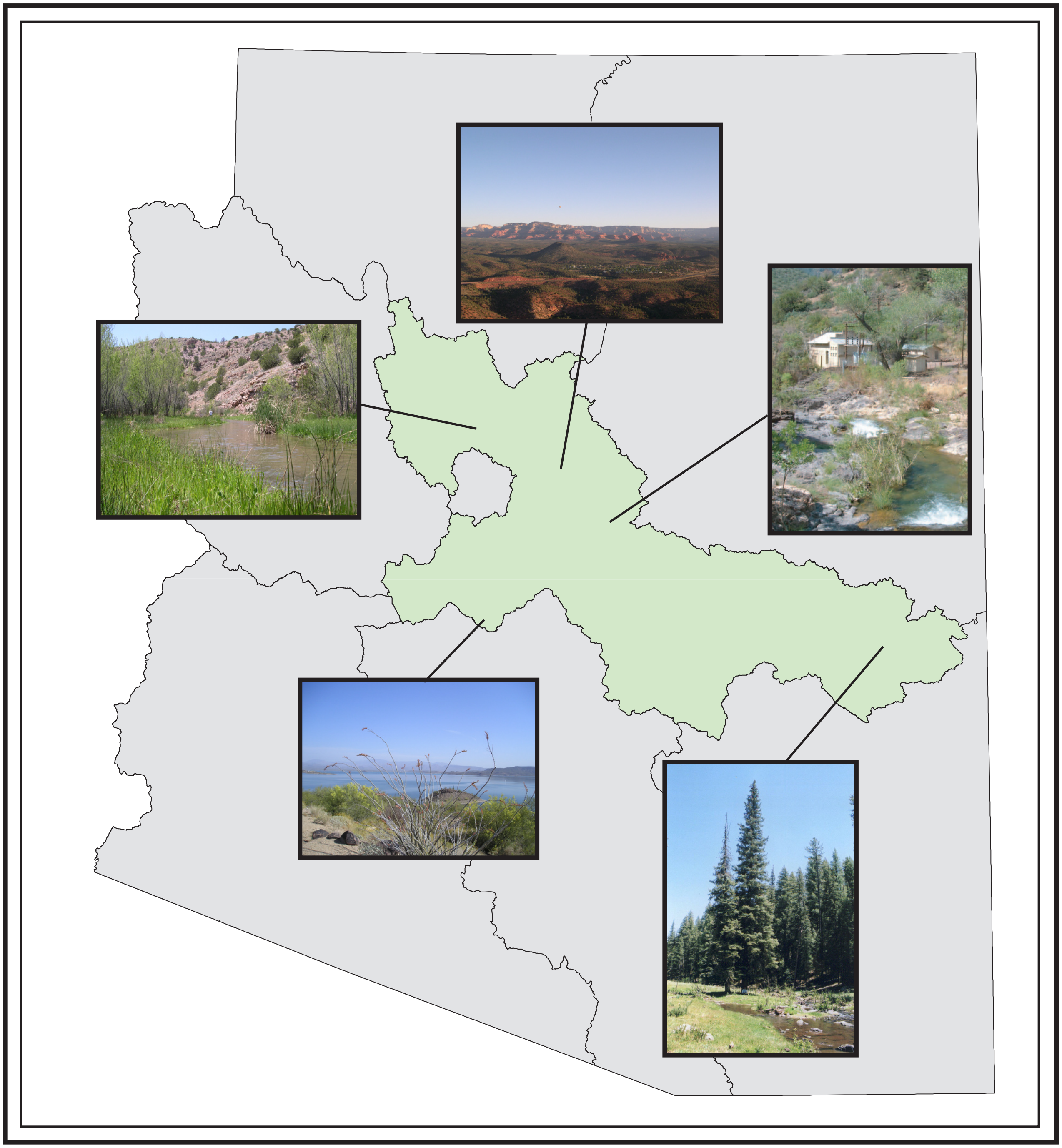
ARIZONA WATER ATLAS
VOLUME 5
CENTRAL HIGHLANDS PLANNING AREA



Arizona Department of Water Resources

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ARIZONA WATER ATLAS
VOLUME 5 - CENTRAL HIGHLANDS PLANNING AREA

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Preface

Volume 5, the Central Highlands Planning Area, is the fifth in a series of nine volumes that comprise the Arizona Water Atlas. The primary objectives in assembling the Atlas are to present an overview of water supply and demand conditions in Arizona, to provide water resource information for planning and resource development purposes and help to identify the needs of communities.

The Atlas divides Arizona into seven planning areas (Figure 5.0-1). There is a separate Atlas volume for each planning area, an introductory volume composed of background information, and an executive summary volume. "Planning areas" are an organizational concept that provide for a regional perspective on supply, demand and water resource issues. A complete discussion of Atlas organization, purpose and scope is found in Volume 1.

There are additional, more detailed data available to those presented in this volume. They may be obtained by contacting the Arizona Department of Water Resources (Department).

5.0 Overview of the Central Highlands Planning Area

The Central Highlands Planning Area is composed of five groundwater basins oriented east-west in central Arizona. This planning area contains areas of higher elevation compared to many other parts of the state and is characterized by narrow valleys separated by steep mountain ranges. Elevation ranges from 1,500 feet to over 12,600 feet. Parts of nine counties are located within the planning area including parts of Apache, Coconino, Gila, Graham, Greenlee, Maricopa, Navajo, Pinal, and Yavapai counties. There are four Indian reservations within the planning area including the Fort Apache, San Carlos Apache, Tonto-Apache, and Yavapai-Apache Indian Reservations.

The 2000 Census planning area population was approximately 145,850. Basin population ranged from about 7,500 in the Tonto Creek Basin to over 88,000 in the Verde River Basin. Payson is the largest metropolitan area with about 13,600 residents in 2000. Other population centers include Camp Verde, Cottonwood/Verde Village/Clarkdale, Globe/Miami and Sedona.

An average of about 77,700 acre-feet of water is used annually in the planning area for agricultural, municipal and industrial uses (cultural water demand). Of this total, approximately 61% is groundwater, 38% is surface water and 1% is effluent. The agricultural demand sector is the largest with approximately 38,000 acre-feet of demand a year - 49% of the total demand. The municipal sector demand is about 22,600 acre-feet a year and industrial demand is about 17,100 acre-feet a year.

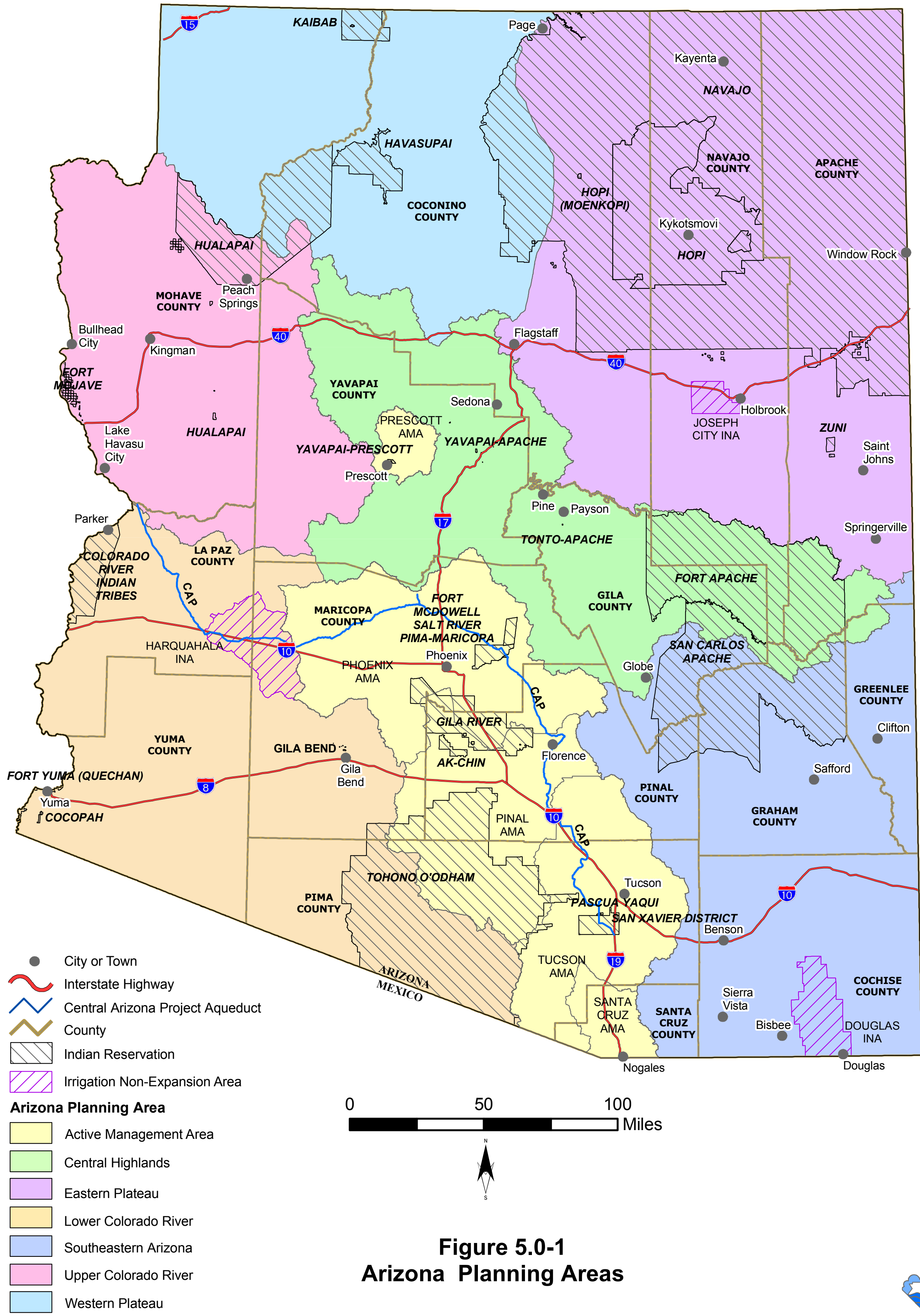


Figure 5.0-1
Arizona Planning Areas

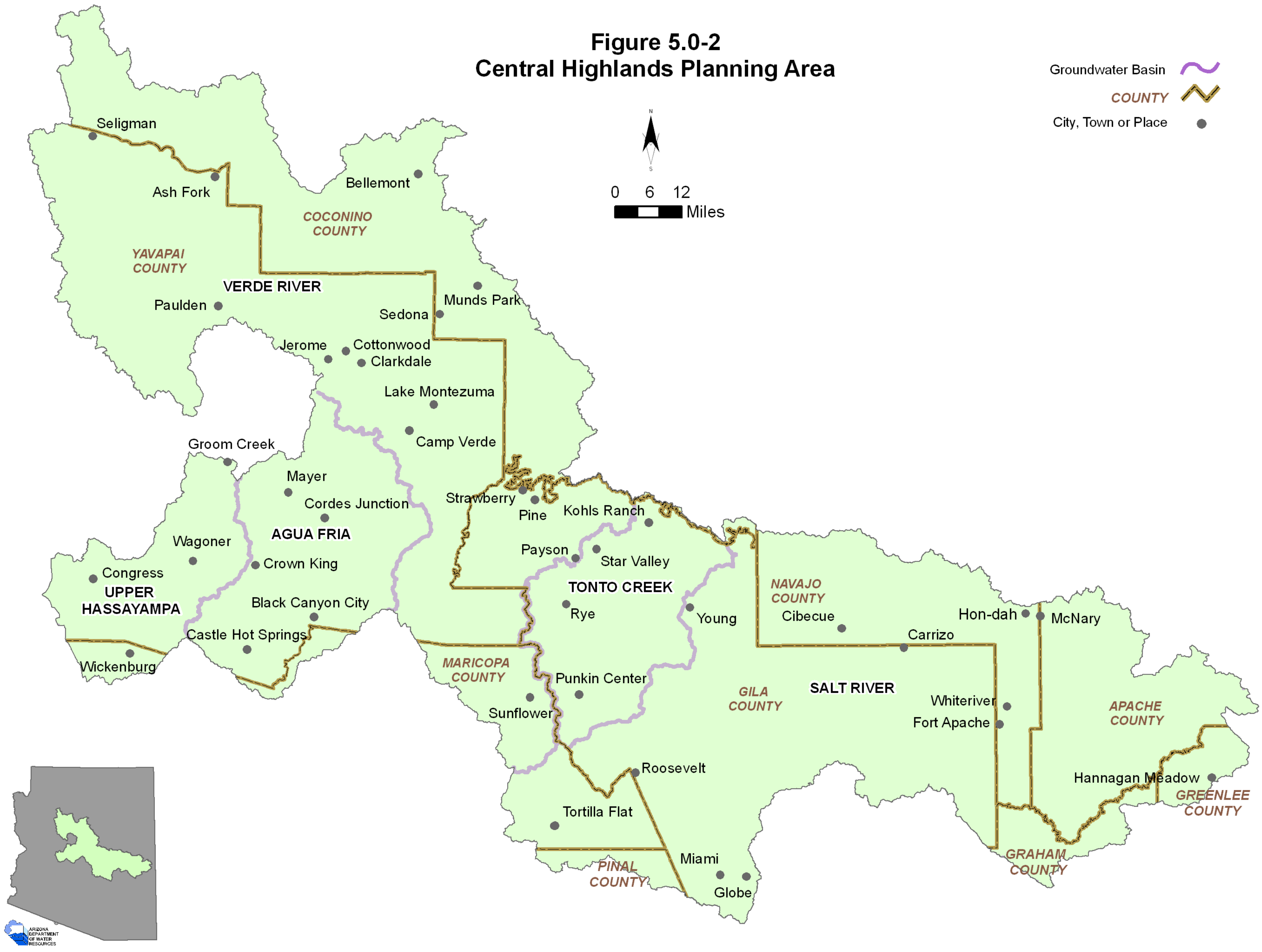
5.0.1 Geography

The Central Highlands Planning Area encompasses about 13,900 square miles and includes the Agua Fria, Salt River, Tonto Creek, Upper Hassayampa and Verde River basins. Basin boundaries, counties and prominent cities, towns and places are shown in Figure 5.0-2. The planning area is bounded on the north by the Coconino Plateau Basin in the Western Plateau Planning Area, on the east by the Eastern Plateau Planning Area, on the south by the Southeastern Arizona Planning Area and the Phoenix Active Management Area (AMA), and on the west by the Prescott AMA and the Upper Colorado River Planning Area (Figure 5.0.1). The planning area includes all or part of three watersheds, which are discussed in section 5.0.2. Within the planning area, the Fort Apache Indian Reservation encompasses about 2,500 square miles and the San Carlos Apache Indian Reservation, most of which is within the Southeastern Arizona Planning Area, encompasses about 500 square miles. The two other reservations are relatively small, totaling only about 740 acres or 1.2 square miles.

Most of the planning area is within the Central Highlands physiographic province, characterized by rugged mountains of igneous, metamorphic and sedimentary rocks. This province is the smallest in terms of area in Arizona and is a transition zone between the Basin and Range Lowlands and Plateau Uplands Provinces (See Volume 1, Figure 1-2). The extreme southwestern part of the planning area extends into the Basin and Range Lowlands physiographic province, which is characterized by northwest-southeast trending mountain ranges separated by broad alluvial valleys. The southern portions of the Agua Fria and Upper Hassayampa basins are indicative of this province. The northwestern part of the planning area falls within the Plateau Uplands physiographic province which is characterized by high desert plateaus and incised canyons. Included in this province are the northern part of the Verde River Basin, and the northern edge of the Tonto Creek and Salt River basins. Elevation ranges from 1,500 feet at Saguaro Lake in the Salt River Basin to 12,633 feet at Humphreys Peak in the San Francisco Mountains at the northeastern edge of the Verde River Basin. High-elevation mountains are also found in the White Mountains in the eastern portion of the Salt River Basin where Mt. Baldy, at 11,403 feet is the highest point.

A unique geographic feature of the planning area is the Mogollon Rim, an escarpment that defines the southern boundary of the Colorado Plateau. The rim is approximately 7,000 feet in elevation with sheer drops of 2,000 feet at some locations. The rim stretches for over a hundred miles and forms much of the northeastern boundary of the planning area. The planning area contains diverse topography and a large elevational range, resulting in a wide diversity of vegetation types and ecosystems, the greatest of any planning area in the state. Topography varies from desert basins in the Hassayampa Basin to deeply incised canyons along the Mogollon Rim and high mountain peaks. Because of the high elevations and associated higher rainfall and snowfall, this planning area contains the state's most important water producing watersheds, the Salt River and the Verde River. These watersheds contain the greatest concentration of perennial streams found in the state, which in turn support extensive riparian habitat.

Figure 5.0-2
Central Highlands Planning Area



5.0.2 Hydrology[1]

Groundwater Hydrology

The Central Highlands Planning Area is characterized by a band of mountains consisting of igneous, metamorphic and sedimentary rocks. High elevations, steep topography, and extensive bedrock result in relatively small water storage capabilities and high runoff in the planning area as compared to the alluvial basins in the State.

Anderson, Freethey and Tucci (1992) divided the alluvial basins in south-central Arizona into five categories based on similar hydrologic and geologic characteristics. One of these, the "Highland Basins", covers most of the planning area with the exception of the Upper Hassayampa Basin, categorized as a "West" basin, and the southern half of the Agua Fria Basin, categorized as a "Central" Basin.

<u>Highland Basins</u>
The Highland basins include the Salt River, Tonto Creek and Verde River basins, and the northern half of the Agua Fria Basin. Basin fill aquifers in the highlands are limited in areal extent and are hydrologically-connected with stream alluvium. Consolidated rock aquifers surround and underlie the basin fill aquifers and contribute underflow. Basin fill aquifers also receive inflow from stream infiltration and mountain front recharge. Where the basin fill aquifers are discontinuous, underflow between them may be restricted (Anderson, et al., 1992)

Agua Fria Basin (northern half)
Groundwater occurs in four geologic units in the Agua Fria Basin: basin fill sands and gravels, volcanic rocks, conglomerates and igneous and metamorphic rocks. Groundwater occurs in volcanic rocks in the northeastern section of the basin that yield relatively small volumes of water. Conglomerates are found throughout the basin and contain the largest volumes of groundwater of any of the rock units. Due to faulting, this unit is separated into smaller discrete basins separated by low permeability crystalline rocks.

Salt River Basin
The Salt River Basin is bounded on the west and southwest by the Sierra Ancha and Superstition Mountains, on the south by the Natanes Plateau and on the east by the White Mountains (see Figure 5.2-1). The Mogollon Rim, a 2,000-foot high escarpment, forms a natural groundwater divide along much of the basin's northern boundary. The Salt River Basin contains four sub-basins: Salt River Lakes, Salt River Canyon, Black River and White River. Figures 5.2-6 and 5.2-8 show the location of the sub-basins. Principal aquifers differ between the sub-basins, with basin fill and alluvial aquifers found in the western portion of the basin and limestone and volcanic aquifers in the eastern portion. Groundwater conditions in each sub-basin, from west to east, are discussed below.

[1] Except as noted, much of the information in this section is taken from the Arizona Water Resources Assessment, Volume II, ADWR August, 1994.

- Salt River Lakes Sub-basin

The Salt River Lakes Sub-basin occupies the western part of the Salt River Basin. Within the sub-basin groundwater is found in igneous granitic, metamorphic, and sedimentary rocks. A basin fill aquifer underlies a large part of the sub-basin including the area around Globe, lower Tonto Creek, the Salt River reservoirs and Pinto Valley west of Miami. Unconsolidated sands and gravels within the floodplains of streams and washes form an alluvial aquifer that is generally the most productive aquifer. Along the Salt River and around Roosevelt Lake, the basin fill is up to 2,000 feet thick (ADWR, 1992). Recharge to the basin fill aquifer occurs primarily along mountain fronts and from streams and lake infiltration.

In the Globe-Miami area the Gila Conglomerate, composed of semi-consolidated to consolidated basin fill sediments, forms a local aquifer. The Gila Conglomerate is up to 4,000 feet thick in this area and provides most of the area's municipal and industrial water supply. A limestone aquifer also supplies water in the Globe-Miami area, and west of Globe several small basin fill deposits form isolated groundwater aquifers (ADWR, 1992). Well yields are generally low in the southeast part of the sub-basin near Globe, and higher north of Globe. Igneous granitic rocks provide small amounts of water for domestic and stock use in the sub-basin.

Mining activities in the Globe-Miami area have impacted water quality in the alluvial aquifer along Pinal Creek and Miami Wash including elevated concentrations of sulfate and metals. Drinking water standards for cadmium, chromium, fluoride, lead, other metals and for total dissolved solids have been equalled or exceeded in a number of wells in the area.

- Salt River Canyon Sub-basin

In the western portion of the Salt River Canyon Sub-basin, sedimentary and igneous granitic rocks are found similar to those in the adjacent Salt River Lakes Sub-basin. The groundwater flow system is complex with disconnected recharge areas and many water-bearing zones located beneath sedimentary and igneous rocks (USGS, 2005a). The rest of the sub-basin is composed primarily of sedimentary rocks, including limestones, sandstones, siltstones, shales and thin conglomerates. These rocks are exposed along the Mogollon Rim and at other locations in the sub-basin. The Natanes Plateau, located along the southern boundary of the sub-basin, is composed of volcanic rock. There is little aquifer data for the area, but based on similar rock units in other areas, there may be useable amounts of water in the Supai Formation, Redwall Limestone, Coconino Sandstone and the undivided sandstones in the sub-basin. These formations may yield moderate amounts of water, up to 100 gpm, however yields can vary widely depending on sub-surface geology (ADWR, 1992). Recharge to the sedimentary rocks occurs mainly along the Mogollon Rim.

Significant basin fill and floodplain alluvial deposits are present along Cherry Creek near the western boundary of the sub-basin. The depth of basin fill deposits in this sub-basin was estimated to be less than 400 feet thick (ADWR, 1992).

- White River Sub-basin

The eastern portion of the White River Sub-basin is covered with volcanics and the western portion contains consolidated sedimentary rocks similar to those found in the Salt River Canyon

Sub-basin. Groundwater occurs in fracture zones and the various volcanic flows, including cinder beds. Groundwater flow in the volcanic aquifer is discontinuous and well yields and water levels may vary widely over short distances. Precipitation in the area is relatively high and recharges the volcanic aquifer through infiltration into the fractured rock. Groundwater discharged from the volcanic aquifer contributes to the baseflow of the White River.

- Black River Sub-basin

The Black River Sub-basin is covered almost entirely by volcanics that include basalt flows, rhyolitic ash flows, tuffs and tuffaceous agglomerates that form layers over 3,000 feet thick in some areas. Wells in this area are low-yield and well depths of 400 to 800 feet are common. As in the White River Sub-basin, the volcanic aquifer is recharged through infiltration of precipitation. Discharge from the aquifer contributes to baseflow in the Black River.

Tonto Creek Basin

In the Tonto Creek Basin, groundwater is found in stream alluvium, basin fill sands and gravel, Paleozoic sedimentary rocks and Precambrian igneous, metamorphic and sedimentary rocks. The primary aquifer occurs in basin fill which underlies a large portion of the basin, from near Rye to the southern basin boundary. The basin fill consists of coarse-grained conglomerate in the lower part of the basin and along the basin margins and locally is overlain by fine-grained mudstone in the center of the basin. The conglomerate may be up to 500 feet thick. Groundwater is also found in the floodplain alluvium which may be as much as 65 feet thick along Tonto Creek. Along the Creek, the basin fill and alluvial aquifers are recharged primarily by stream infiltration.

A limestone aquifer is utilized along the Mogollon Rim where groundwater movement and well yield are dependent on faults, fractures and solution cavities. Wells in the limestone aquifer generally yield less than 100 gpm. The aquifers within the sedimentary rocks are recharged from precipitation on the southern edge of the Colorado Plateau (USGS, 2005a). Fractured bedrock yields small volumes of water to wells east of Payson (ADWR, 1992). Since most of the land in the basin is National Forest land, there has been little groundwater development and aquifer characteristics are not well defined. Groundwater quality is generally good although drinking water standards for arsenic, radionuclides, nitrate/nitrite and organics have been equalled or exceeded in some wells.

Verde River Basin

The Verde River Basin encompasses part of the Coconino Plateau in its northern portion while the Mogollon Rim defines its eastern boundary. It is characterized by steep canyons, rugged mountains and broad alluvial valleys in the north and west-central portions of the basin. The basin is divided into the Big Chino, Verde Valley and Verde Canyon sub-basins, which are discussed from north to south below. A number of hydrogeologic studies of the Big Chino and Verde Valley sub-basins, and to a lesser extent the Verde Canyon sub-basin, have been conducted and are briefly referenced here. These studies, many of them very recent, contain detailed information about the groundwater system as well as the surface water system of the Verde River Basin. Figures 5.5-6 and 5.5-8 show the locations of the sub-basins.

- Big Chino Sub-basin

The Big Chino Sub-basin has an area of about 1,850 square miles. The principal aquifer consists of basin fill sediments interbedded with volcanic rocks of Cenozoic age that fill the sub-basin. This basin fill aquifer is commonly referred to as the Chino Valley Unit and is the major source of water for irrigation and domestic purposes. Chino Valley runs northwest to southeast from Seligman to Paulden. Well yields in Chino Valley wells are commonly greater than 1,000 gpm to greater than 2,000 gpm. A carbonate aquifer comprised of Paleozoic rocks underlies most of the Big Chino Valley Sub-basin and the area north of the Verde River near Paulden. It is assumed that there is a hydraulic connection between the two aquifers in the Big Chino Valley and the Williamson Valley, which runs north-south along the southeastern sub-basin boundary.

In the basin fill aquifer, groundwater occurs under unconfined and confined (artesian) conditions. Artesian conditions occur primarily where buried lava flows and coarse-grained sediments are interbedded with clays and volcanic ash. Recharge occurs from mountain front recharge and from runoff in major washes. In the northwesternmost part of the sub-basin, basin fill deposits may be as much as 2,500 feet thick. Further south and west of Paulden in the Williamson Valley, the thickness of the alluvium is estimated at 2,000 feet. In the eastern part of the Big Chino Sub-basin, the carbonate aquifer is the primary regional aquifer. This aquifer is dry west of the Mesa Butte Fault and between Williams and the Big Chino Valley (USGS, 2006). Alluvial sands and gravels along the major washes also yield water to wells and are utilized as a local water supply in the sub-basin. Water quality is generally good in the sub-basin with some occurrence of arsenic at levels that equal or exceed the drinking water standard in wells in the Paulden area.

Aquifer recharge occurs along the Juniper and Santa Maria Mountains on the west side of the sub-basin, from Granite Mountain on the south and from Big Black Mesa and Bill Williams Mountain on the east side of Chino Valley. Recharge also occurs via groundwater inflow from the Little Chino Sub-basin (Prescott AMA) north of Del Rio Springs. In 1999, this inflow was estimated at 1,800 acre-feet per year (Nelson, 2002). Groundwater outflow from the Big Chino Sub-basin occurs as base flow in the Verde River and is currently estimated at about 17,700 acre-feet/year. Base flow at the Verde River near Paulden (gage number 9503700, see Figure 5.5-4) has declined at an annual rate of about 380 acre-feet per year since the mid-1990s (USGS, 2006).

- Verde Valley Sub-basin

The Verde Valley Sub-basin has an area of about 2,500 square miles. The principal aquifer in the sub-basin is the Verde Formation, which consists of a thick sequence of limestones and sandstones. The estimated depth of the formation is 4,200 feet based on aeromagnetic and gravity data (USGS, 2006). Other aquifers include the carbonate aquifer and an alluvial aquifer located along the Verde River. Groundwater occurs primarily under unconfined conditions although confined conditions occur locally within the Verde Formation. All three aquifers are hydraulically connected. The main groundwater supply for Sedona is in sandstone of the Supai Formation and the underlying Redwall and Martin limestones (carbonate aquifer). Locally perched groundwater in fractured or decomposed granite and in volcanic rocks provide small amounts of water in many locations. Groundwater is generally of good quality at most locations, although the drinking water standard for arsenic has been equaled or exceeded in several wells (see Table 5.5-7).

Most groundwater enters the sub-basin from the Coconino Plateau. Groundwater moves through the carbonate aquifer and discharges at springs and seeps along tributaries of the Verde River, or flows into the Verde Formation and stream-channel alluvium (USGS, 2006). The Oak Creek Fault system is an important influence on the transmission of water between aquifers and to the surface, as evidenced by the large number of major springs along Oak Creek (see Figure 5.5-5). Groundwater primarily flows toward the Verde drainage and exits the sub-basin in the southeast through alluvium and volcanic rocks along the river.

Recharge to the Verde Formation aquifer is from high elevation precipitation along the Mogollon Rim and on the Coconino Plateau with additional contributions from stream infiltration. The carbonate aquifer also receives recharge from high altitudes along the Mogollon Rim, and from an area between the San Francisco Peaks and Bill Williams Mountain (USGS, 2006). Most recharge comes from winter precipitation.

- Verde Canyon Sub-basin

There is relatively little groundwater development in the Verde Canyon Sub-basin. Basalt flows, conglomerates and semi-consolidated silt units cover a large part of the sub-basin. The groundwater system is complex with disconnected recharge areas and multiple water-bearing zones. Because of its complexity our understanding of the groundwater system is often limited to local analysis of spring and well data. Recharge to the groundwater system originates primarily along the crest of the Mogollon Rim where precipitation and snowmelt percolate through permeable volcanic, limestone or sandstone units (USGS 2005a). Spring discharge and stream base flow appear to be the largest components of aquifer outflow. Water quality is generally good in the sub-basin although the drinking water standards for arsenic, beryllium, cadmium, lead, selenium and organics have been equaled or exceeded in wells in the Payson area and for arsenic in Pine.

In Payson, groundwater is withdrawn primarily from fractured and faulted granite. Most wells are shallow, although the town of Payson has conducted exploratory drilling north of the town where deep water-bearing zones were found. A recent study suggests that a segment of the Diamond Rim fault system northeast of Payson may have groundwater supply potential (Gæaorama, 2006). The shallow water-bearing zones around Payson depend on winter recharge and are therefore very sensitive to drought. Water in deeper fracture systems in the area may be fed from the Mogollon Rim and less affected by droughts. Well yields in the area are typically less than 500 gpm.

In Strawberry, most wells are completed in the Schnebly Hill Formation, a sandstone unit that is the major component of the “Red Rocks” of Sedona. Well yields in the area typically range from 20 to 80 gpm. An exploratory well drilled near Strawberry in 2000 encountered water in the Redwall Limestone at about 1,380 feet (Corkhill, 2000). At nearby Pine, most wells are completed in the Supai Formation, which is composed of sandstone, siltstone, and mudstone with some interbedded limestone. Well yields in Pine are typically lower than Strawberry and range from 10 to 30 gpm. These relatively low well yields suggest a more localized groundwater system (USGS, 2005a). There is little water use in the southern half of the sub-basin where unconsolidated sediments are found.

West Basins

The Upper Hassayampa Basin was defined by Anderson, Freethey and Tucci (1992) as a “West” basin. These basins are generally arid and groundwater inflow and outflow are relatively small with little or no stream baseflow. The main aquifer in the Upper Hassayampa Basin is basin fill deposits found along valleys between the mountains. These deposits consist of gravel, sand, silt and clay. In the mountainous portions of the basin, fractured crystalline and consolidated sedimentary rocks yield small amounts of water to wells. North of the Vulture Mountains in the southwestern part of the basin, the basin fill varies from a few tens of feet thick to over 1,000 feet thick near the middle of the valley. Near Wagoner, stream deposits overlying crystalline rock are up to 135 feet thick. Groundwater quality is generally good in the basin although drinking water standards for arsenic and other metals have been equaled or exceeded in wells near Wickenburg.

Central Basins

The southern half of the Agua Fria Basin was categorized by Anderson, Freethey and Tucci (1992) as a central basin. Central basins are characterized by deep alluvial sediments with small to moderate amounts of mountain front recharge and streamflow infiltration. The principal aquifers in the Agua Fria Basin are upper basin fill, which occurs under unconfined conditions, and sedimentary rock (conglomerate), which is found throughout the basin and contains the largest volume of groundwater. Castle Hot Springs, located in the southwest part of the basin, discharge 340 gpm from Precambrian rocks. By comparison, wells in Precambrian schist near Black Canyon City have relatively low yields. Arsenic and fluoride concentrations at levels that equal or exceed drinking water standards have been detected in springs and wells near Black Canyon City and in Castle Hot Springs.

Surface Water Hydrology

The U.S. Geological Survey (USGS) divides and subdivides the United States into successively smaller hydrologic units based on hydrologic features. These units are classified into four levels. From largest to smallest these are: regions, subregions, accounting units and cataloging units. A hydrologic unit code (HUC) consisting of two digits for each level in the system is used to identify any hydrologic area (Seaber et al., 1987). A 6-digit code corresponds to accounting units, which are used by the USGS for designing and managing the National Water Data Network. There are portions of three watersheds in the planning area at the accounting unit level; the Agua Fria River-Lower Gila River, the Salt River and the Verde River. (Figure 5.0-3).

The Agua Fria-Lower Gila River

The Agua Fria-Lower Gila River watershed extends from near Prescott to south of Gila Bend in the Lower Colorado River Planning Area. It includes the drainage areas of the Agua Fria River, the Hassayampa River and the Gila River from below its confluence with the Salt River Basin to Painted Rock Dam. Within the planning area, this watershed covers the Agua Fria Basin and the

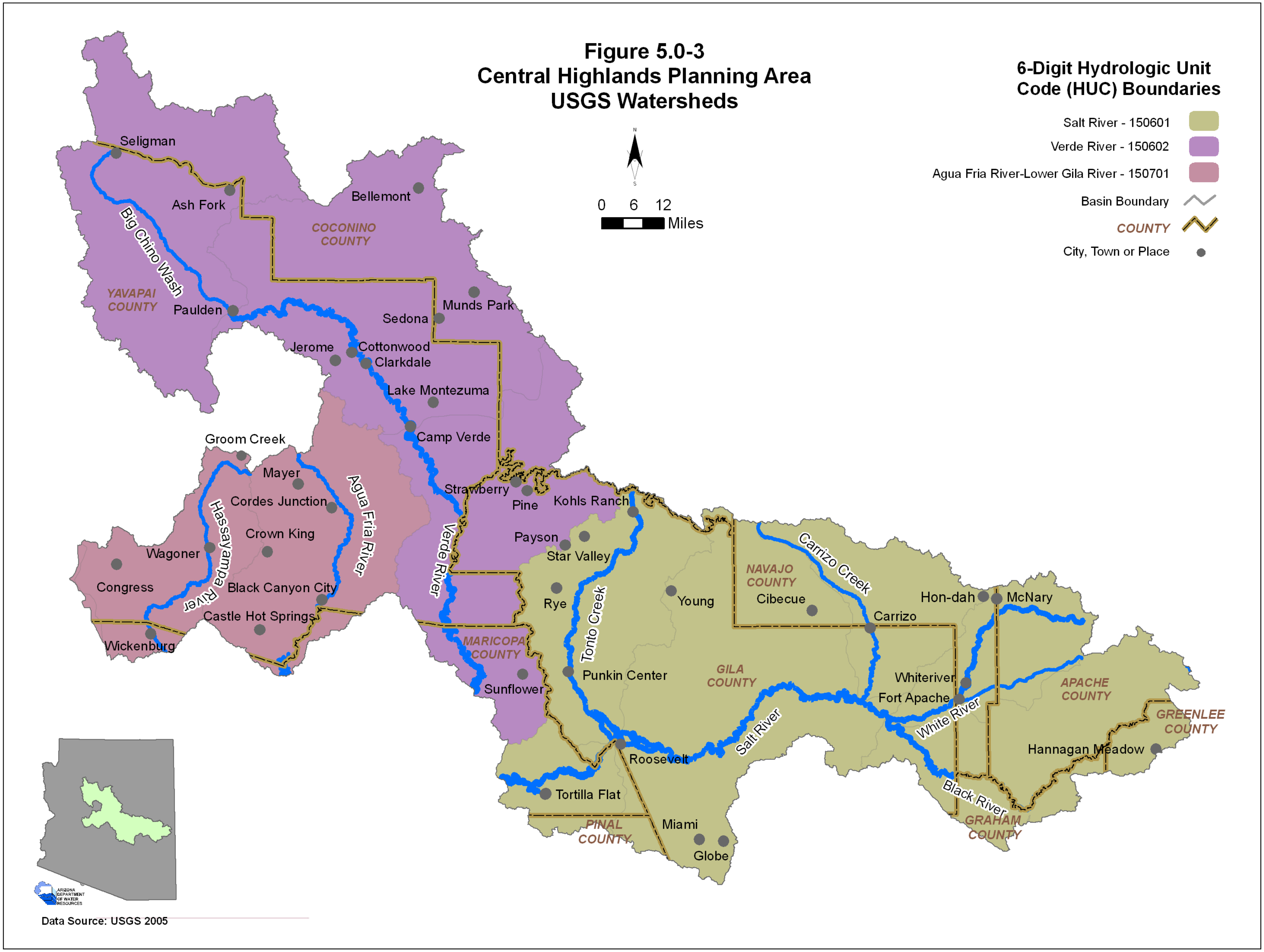


Figure 5.0-3
Central Highlands Planning Area
USGS Watersheds
6-Digit Hydrologic Unit Code (HUC) Boundaries
Salt River - 150601
Verde River - 150602
Agua Fria River-Lower Gila River - 150701
Basin Boundary
COUNTY
City, Town or Place
0 6 12
Miles
Seligman
Ash Fork
Bellemont
COCONINO COUNTY
YAVAPAI COUNTY
Big Chino Wash
Paulden
Sedona
Munds Park
Jerome
Cottonwood
Clarkdale
Lake Montezuma
Camp Verde
Groom Creek
Mayer
Cordes Junction
Crown King
Wagoner
Congress
Hassayampa River
Agua Fria River
Black Canyon City
Castle Hot Springs
Wickenburg
Verde River
Strawberry
Pine
Kohls Ranch
Payson
Star Valley
Rye
Tonto Creek
Young
Punkin Center
MARICOPA COUNTY
Sunflower
NAVAJO COUNTY
Cibecue
Carrizo Creek
Carrizo
Hon-dah
McNary
GILA COUNTY
Whiteriver
Fort Apache
White River
APACHE COUNTY
GREENLEE COUNTY
Hannagan Meadow
Salt River
Roosevelt
Tortilla Flat
PINAL COUNTY
Miami
Globe
Black River
GRAHAM COUNTY
Data Source: USGS 2005

Upper Hassayampa Basin.

The Agua Fria River drains an area of about 2,700 square miles with elevations ranging from 7,800 feet in the Bradshaw Mountains, which define part of its western boundary, to 1,570 feet at Lake Pleasant, which is impounded by New Waddell Dam at the southern boundary of the Agua Fria Basin. The Agua Fria River only flows below the dam when water is released during major flood events. It is tributary to the Gila River a short distance downstream of the confluence of the Salt and Gila Rivers near Goodyear in the Phoenix AMA. The Agua Fria River is perennial at several reaches within the Agua Fria Basin: above Lake Pleasant south of Black Canyon City; through portions of the Agua Fria National Monument; and in the northern part of the basin (see Figure 5.1-5). Tributaries to the Agua Fria River with perennial reaches include Little Ash, Sycamore, and Silver creeks. Other tributaries to the river are generally intermittent or ephemeral.

The Hassayampa River originates in the northern Bradshaw Mountains and flows through the Upper Hassayampa Basin and the Phoenix AMA to its confluence with the Gila River. The river drains a total of about 1,470 square miles. It is perennial in the northern portion of the Upper Hassayampa Basin in the vicinity of Groom Creek, and in the reach south of Wickenburg. A major fault crosses the river seven miles downstream from Wickenburg at “the Narrows”, which forms the southern boundary of the basin. At this point, the entire flow of the river sinks into the streambed. The only other perennial reaches within the basin are short reaches of Minnehaha, Ash, Weaver and Antelope creeks (AGFD, 1993).

There are three currently operating streamflow gages in the watershed, all located in the Agua Fria Basin. These include real-time gages on the Agua Fria River near Humboldt, Mayer and Rock Springs. The maximum recoded annual flow in the watershed was 360,541 acre-feet at the Rock Springs Gage in 1992. The median annual flow at this location is 19,692 acre-feet and the minimum annual flow was 1,528 acre-feet in 1975 (see Table 5.1-2). There are currently no operating streamflow gages in the Hassayampa River drainage of the watershed. The gage with the longest record (35 years), was located north of Wickenburg and was discontinued in 1982. During its period of operation, the highest annual flow recorded was 123,076 acre-feet in 1980, and its median flow was 7,457 acre-feet (see Table 5.4-2).

There are approximately 460 total springs located in the watershed. Only five springs with a discharge of 10 gpm or greater have been reported and all are located in the Agua Fria Basin. Discharges from those springs were last measured during or prior to 1982, therefore these rates may not be indicative of current conditions. The largest spring is Castle Spring, with a reported discharge of 340 gpm and a temperature of 131°F. It is located northwest of Lake Pleasant at Castle Hot Springs, reportedly Arizona’s first resort which opened in 1896. The four other large springs have discharge rates less than 100 gpm and are located in the northeastern portion of the basin (see Figure 5.1-5). There are 14 minor springs (discharge of 1-10 gpm) in the watershed, also located in the Agua Fria Basin. While there are no large or small springs in the Upper Hassayampa Basin, there are approximately 164 to 166 springs with a discharge of less than 1gpm.

Within the watershed, reaches of Turkey Creek in the Agua Fria Basin, and Cash Mine Creek, French Gulch and the Hassayampa River in the Upper Hassayampa Basin have surface waters with impaired water quality. Parameters of concern include cadmium, copper, zinc, pH and lead due to mining activities in the area.

<u>The Salt River</u>

The surface water characteristics of the Salt River watershed are influenced by precipitation patterns, topography and geology. The Salt River and Tonto Creek basins comprise most of the watershed with the exception of the westernmost part, which extends to the confluence of the Salt and Gila rivers in the Phoenix AMA. The Salt River is the largest tributary of the Gila River, with a drainage area of about 5,980 square miles. Its headwaters are the White and Black rivers that originate in the high elevations of the Salt River Basin where winter snow accumulation is critical to downstream water supplies. This area is the most prolific producer of surface water in Arizona with unit runoff values of as much as 674 acre-feet/square mile (12.6 inches) in the drainage of the East Fork of the White River (ADWR, 1992) (See Figure 5.2-4). By comparison, the Tonto Creek Basin has a unit runoff of about 165 acre-feet/square mile (3.1 inches). Within the planning area, the elevation of the watershed ranges from near 11,400 feet in the White Mountains to 1,500 feet at Saguaro Lake.

There are many perennial streams in the watershed, particularly in the Salt River Basin (see Figures 5.2-5 and 5.3-5). The Salt River and Tonto Creek are both perennial throughout their lengths in the planning area. Numerous small streams that begin along the Mogollon Rim and the White Mountains feed tributaries of the Salt River and Tonto Creek. Perennial flow in these streams is primarily due to geologic features (e.g. joints and fractures) that cause groundwater to surface and discharge to streams.

Surface water from the watershed flows into Theodore Roosevelt Lake, and is subsequently released to a series of three downstream reservoirs along the Salt River; Apache Lake, Canyon Lake and Saguaro Lake. These reservoirs and their associated dams are operated by the Salt River Project (SRP) for the benefit of agricultural, municipal and industrial users in the Phoenix metropolitan area. Figure 5.0-4 shows the capacity of the SRP reservoir system on both the Salt and the Verde systems. Also shown is C.C. Cragin Reservoir, formerly known as Blue Ridge Reservoir. Water stored at C.C. Cragin, located in the Eastern Plateau Planning Area, is diverted by pipeline to the East Verde River in the Verde Watershed. Surface water stored in this reservoir and in the Salt and Verde system is not generally available for use in the Central Highlands Planning Area.

The Salt River system dams were constructed beginning in 1911 with completion of Roosevelt Dam. Mormon Flat Dam was completed in 1926, followed by Horse Mesa in 1927 and Stewart Mountain in 1930. Prior to dam construction, the flow in the Salt River was heaviest in the spring and early summer. Flow is now regulated in response to flood control and downstream water demand. As a result, flows below the reservoirs are generally highest during June-August when water demand is greatest in the Phoenix metropolitan area or when high inflow to the reservoirs necessitates release of water from the dams. In February 1980, a wet winter combined with a storm that dropped up to ten inches of rainfall on the watershed resulted in the largest controlled flood ever to go down the Salt River. Releases from Roosevelt Dam peaked at 180,000 cfs and the water level behind the dam was inches from overflowing the crest (SRP, 2007).

Figure 5.0-4. SRP Reservoir System Capacity

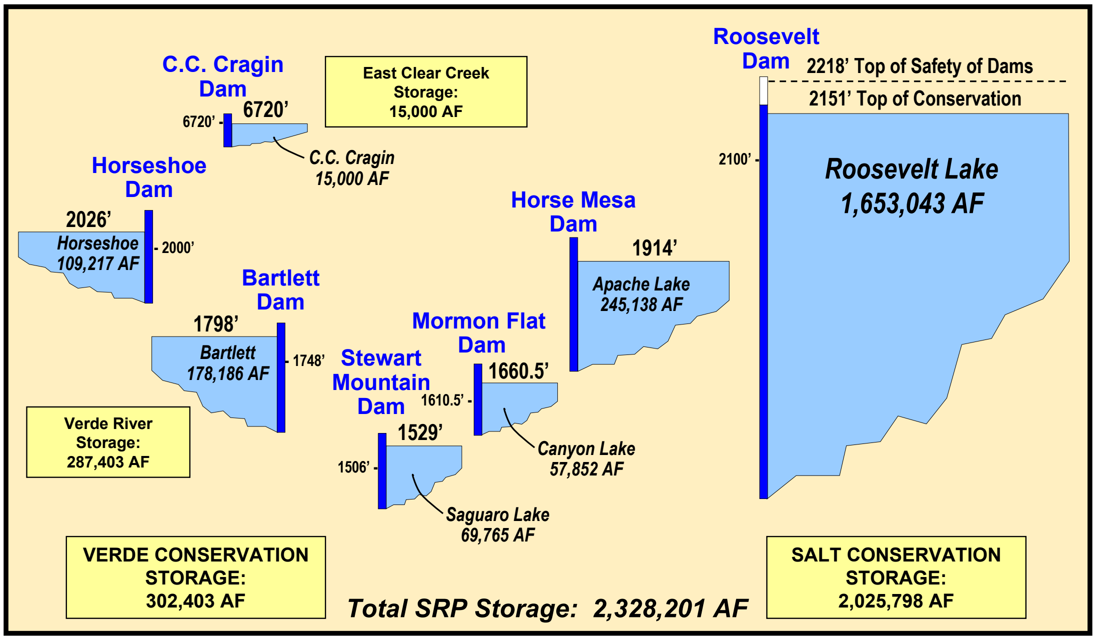


Figure Courtesy of SRP

Annual streamflow of the Salt River fluctuates widely. The nearest gage upstream from Roosevelt Lake, with a contributing drainage area of 4,306 mi^2, has been in operation since 1913. The maximum annual flow was over 2.4 maf in 1916, median annual flow has been 518,499 acre-feet and mean annual flow 644,942 acre-feet. In 2002, an extreme drought year, flow into Roosevelt Lake was at its minimum, about 153,000 acre-feet (Table 5.2-2). Except for changes due to timber harvesting and beaver removal, the upstream reaches of the river have not been significantly altered (Tellman et al., 1997). Typically, timber harvesting and fire in mature forests increases watersehd yields due to elimination of the plant cover. As woody and herbaceous vegetation becomes established, streamflows decline. Recent severe fires in the basin resulted in significant increases in peak flow at several locations. (Neary, et al., 2003)

In the Tonto Creek Basin there is one currently operating, real-time gage located near the community of Roosevelt north of Gun Creek. The maximum annual flow at this point was more than 469,000 acre-feet in 1978. The median annual flow has been about 66,000 acre-feet. Similar to the record low flow in the Salt River, the minimum annual flow was about 2,900 acre-feet in 2002 (Table 5.3-2).

There are a relatively large number of major springs in the Salt River watershed. In the Tonto Creek Basin, several major springs are located below the Mogollon Rim where groundwater is discharged from southward dipping rocks of a limestone aquifer. Tonto Spring at the headwaters of Tonto Creek is the largest spring in the Tonto Creek Basin with a measured discharge of 1,291 gpm. Its flow has been relatively stable, and its isotopic and specific-conductance data are similar to those for Fossil Springs in the Verde River Watershed. This suggests that the same limestone aquifer supplies both springs, which are located approximately 20 miles apart (USGS, 2005b). In the Salt River Basin, there is a high concentration of major springs near McNary, where springs emanate from fractured basalt. Alchesay Spring, which issues from the Supai Formation along the

North Fork of the White River, has the greatest reported discharge measurement in the watershed (over 9,000 gpm). Travertine deposition due to high concentrations of calcium carbonate in source waters occurs at this spring and at Warm Spring along the Salt River (ADWR, 1992).

Several lakes and streams in the watershed have impaired water quality. Reaches of Tonto Creek and Christopher Creek in the Tonto Creek Basin have exceeded standards for E. coli and nitrate/nitrite. The entire reach of Pinto Creek in the Salt River Basin has exceeded the standard for copper due to mining activities in the area. Two lakes in the Salt River Basin have impaired waters including Canyon Lake (dissolved oxygen) and Crescent Lake (high pH) (see Tables 5.2-7 and 5.3-7).

Verde River

Most of the Verde River watershed, and its major watercourse, the Verde River, is located within the boundaries of the Verde River Basin. Within the planning area, the elevation of the Verde River watershed ranges from about 12,600 feet at Humphrey's Peak to about 1,750 feet at Bartlett Dam. The entire watershed encompasses about 6,188 square miles and extends into the Phoenix AMA to the confluence of the Verde River with the Salt River. The upper parts of the watershed include Big Chino Wash, which originates east of the Aubrey Cliffs northwest of Seligman, and Oak Creek which originates on the Coconino Plateau in the northeastern part of the watershed. Big Chino Wash is an ephemeral stream that flows southeasterly to Sullivan Lake while Oak Creek is a perennial stream that merges with the Verde River south of Cottonwood.

The Verde River originates in a steep-walled volcanic rock canyon near Paulden below Sullivan Lake Dam (now almost entirely filled with sediment). Springs feed the headwaters near the upper end of Stillman Lake. The lake has been formed from sediment deposited in the river at the Granite Creek confluence, which causes the river to back-up in its channel. The lake is a narrow, 3,900 feet-long, 20-acre impoundment (USFWS, 2007). Just below the confluence with Granite Creek, a large diffuse spring network, including Big Chino Spring and Sullivan Lake Spring, sustain perennial flow in the river. A USGS study found that discharge from the springs below Sullivan Dam are derived from three groundwater sources; the western part of the Coconino Plateau, the Big Chino Sub-basin and the Little Chino Sub-basin (the Prescott AMA) (USGS, 2006). Another USGS study used geochemistry and tracer-study data to estimate the various base flow contributions to the Verde River. It reported that 80-86% of the base flow is from the Big Chino Sub-basin, 14% from the Little Chino Sub-basin, 10-15% from the Devonian-Cambrian zone of the regional carbonate aquifer and <6% from the Mississippi-Devonian sequence of the regional carbonate aquifer (USGS, 2005c).

Below Granite Creek, the Verde River flows eastward to Perkinsville, southeastward to Fossil Creek, then southward through two reservoirs, Horseshoe and Bartlett, before its confluence with the Salt River. Bartlett Dam was constructed between 1936-1939 to store water for irrigation and other uses in the Phoenix metropolitan area. Ten miles upstream, Horseshoe Dam was completed in 1946 by Phelps Dodge for the Salt River Valley Water Users' Association under a water exchange agreement. Both reservoirs are operated by SRP.

The Verde River is perennial throughout its length from just below Sullivan Lake Dam. Almost all the major perennial tributaries to the river drain areas to the north and east. In addition to Oak Creek, other major tributaries are Wet Beaver Creek, West Clear Creek, Sycamore Creek (at Fort McDowell) and East Verde River. Stream flows in the watershed can be substantial given the high elevation and associated high rainfall and snowfall. Several stream gages on the Verde and its tributaries have reported annual maximum flows exceeding one million acre-feet a year. These gages are the Oak Creek gage near Cornville, the Verde River below Tangle Creek above Horseshoe Dam, and the Verde River at Bartlett Reservoir near Cave Creek. The median flows at these gages are about 531,000 acre-feet, 131,000 acre-feet and 245,000 acre-feet, respectively (see Table 5.5-2). The lowest flow reported at the Oak Creek gage was about 214,500 acre-feet in 1956.

There are many major and minor springs in the Verde River Basin (see Table 5.5-5) including Fossil Springs, near Strawberry, with a total discharge of 21,647 gpm. Fossil Springs consist of several dozen discharge points with most of the flow emanating from about a half dozen points. The largest of the springs reportedly issues from the Fossil Springs fault while other springs issue from the Naco Formation near the contact with the underlying Redwall limestone (Gæaorama Inc., 2006). The Naco Formation consists of interbedded grayish limestone and limey claystone and is located between the overlying Supai Formation and the Redwall limestone in this area (Corkhill, 2000). The chemistry of the springs below the Mogollon Rim is characteristic of water from the Coconino Aquifer, suggesting its source. Fossil Springs contain elevated concentrations of calcium, magnesium, and bicarbonate as well as chloride and sulfate (USGS, 2005a). Calcium carbonate precipitates out below the springs and forms travertine dams along Fossil Creek.

Major springs also occur along upper and lower Oak Creek. In the north half of Oak Creek Canyon, water moves along fractured rock of the Oak Creek fault zone to discharge at springs along the creek (Owen-Joyce, 1983). Concentrations of springs are also found along lower Oak Creek, south of Camp Verde and below the Mogollon Rim north of Payson. Here, water infiltrating through sedimentary rocks discharges at springs along the face of the rim at fractures or at the interface of permeable and less permeable rocks.

Impaired surface waters in the Verde Watershed occur along the East Verde River (selenium), Oak Creek (E. coli), Pecks Lake (dissolved oxygen, high pH and nutrients), Stoneman Lake (dissolved oxygen, high pH and nutrients), Whitehorse Lake (dissolved oxygen) and along reaches of the Verde River (turbidity). (See Table 5.5-7 and Figure 5.5-9).

5.0.3 Climate[2]

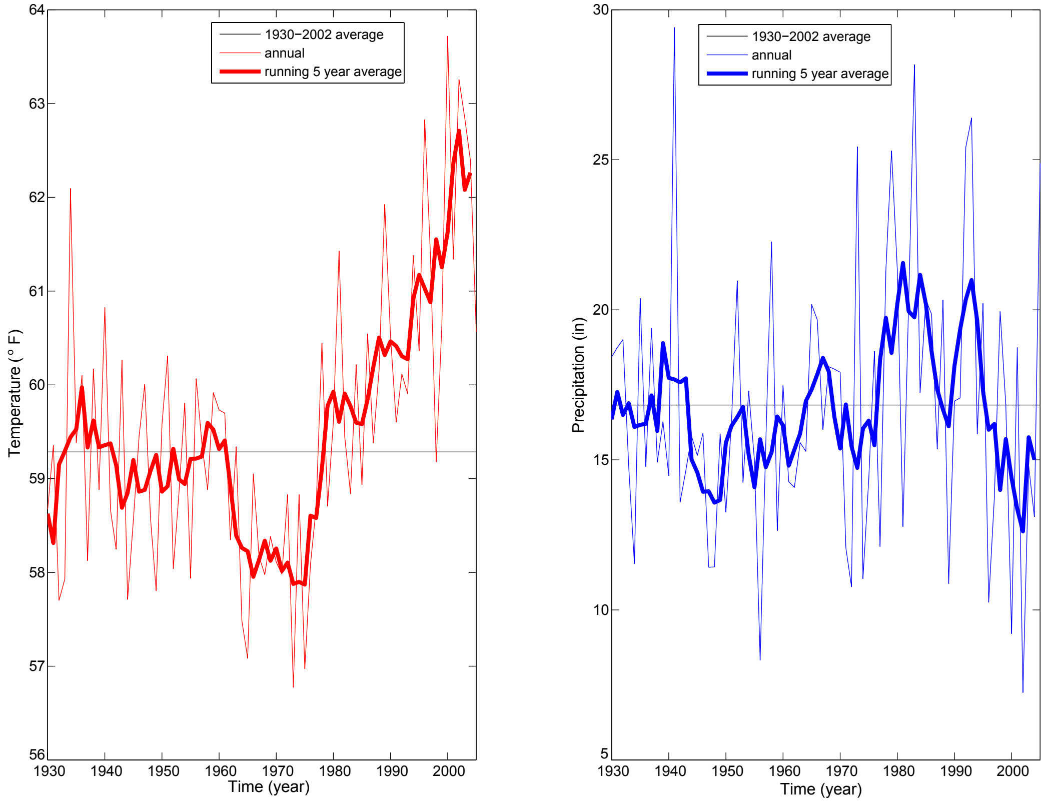
The high country of the Mogollon Rim is a significant topographic barrier to regional airflow, making the climate of the Central Highlands Planning Area wetter and cooler than the rest of the state. The area-weighted average of water-year precipitation for Arizona Climate Divisions 3 and 4 (Yavapai and Gila counties, respectively) is 16.8 inches, which is significantly wetter than the statewide average of 12.1 inches. A climate division is a region within a state that is generally

[2] Information in this section was provided by Institute for the Study of Planet Earth, Climate Assessment for the Southwest (CLIMAS), University of Arizona, May, 2007.

climatically homogeneous. Arizona is divided into seven climate divisions. The area-weighted average water-year temperature is 59.3°F (Figure 5.0-5), which is slightly cooler than the statewide average of 59.9°F.

While average temperatures are slightly cooler than the statewide average, they have been warming during the last 70+ years (Figure 5.0-5). Recent studies show an observed increase, throughout much of the West, in the fraction of winter precipitation falling as rain, rather than snow, at low-to-middle elevations (up to around 8000’). If this trend continues, the timing, amount and distribution of spring runoff is likely to be affected.

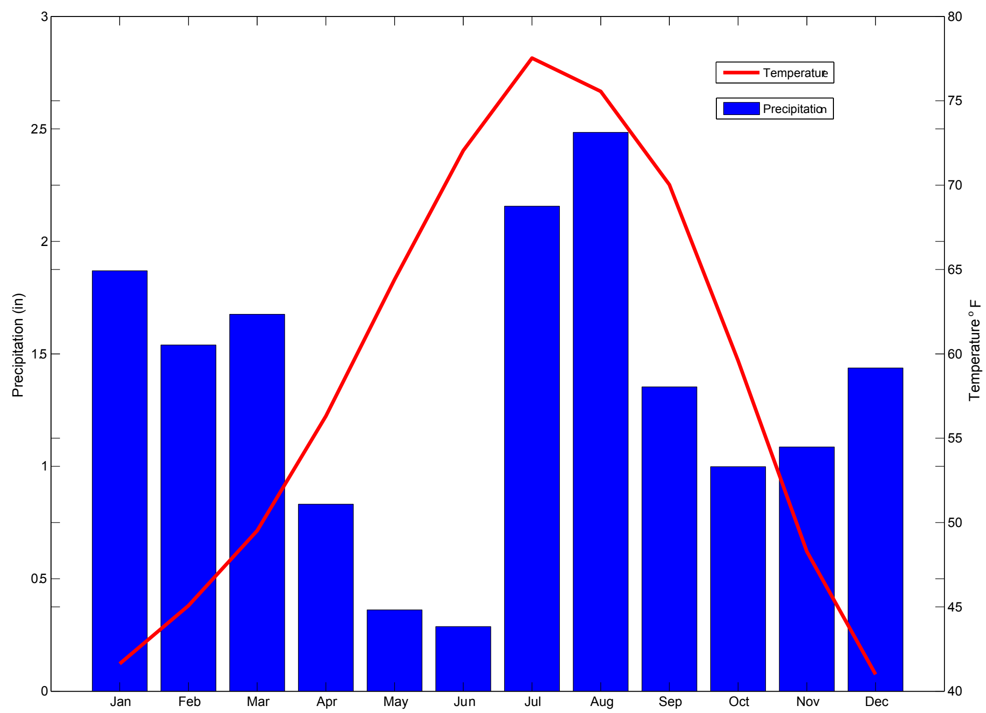
Figure 5.0-5 Average temperature and total precipitation in the Central Highlands Planning area from 1930-2002



Horizontal lines are average temperature and precipitation, respectively. Light lines are yearly values and highlighted lines are 5-year moving average values, Data are from U.S. Historical Climatology Network. Figure author: Ben Crawford, CLIMAS

Precipitation in the Central Highlands has a bi-modal pattern (both winter *and* summer precipitation peaks) characteristic of Arizona (Figure 5.0-6); however, the planning area receives a greater fraction of its precipitation during the winter months than, for example, southeastern Arizona. During winter, precipitation comes during the passage of frontal storm systems moving west-to-east guided by the jet stream, typically located north of Arizona, but occasionally traversing the state. As moist air masses encounter the Mogollon Rim they are lifted and cooled, which condenses water vapor and enhances precipitation along the Rim. Winter precipitation stored as snow is important for planning area water resources. Cooler temperatures and less intense sunlight during winter combine to reduce evaporation, and, in most years, allow snow cover to persist until spring, when gradually melting snow replenishes surface water supplies.

Figure 5.0-6 Average monthly precipitation and temperature in the Central Highlands Planning Area 1930-2002

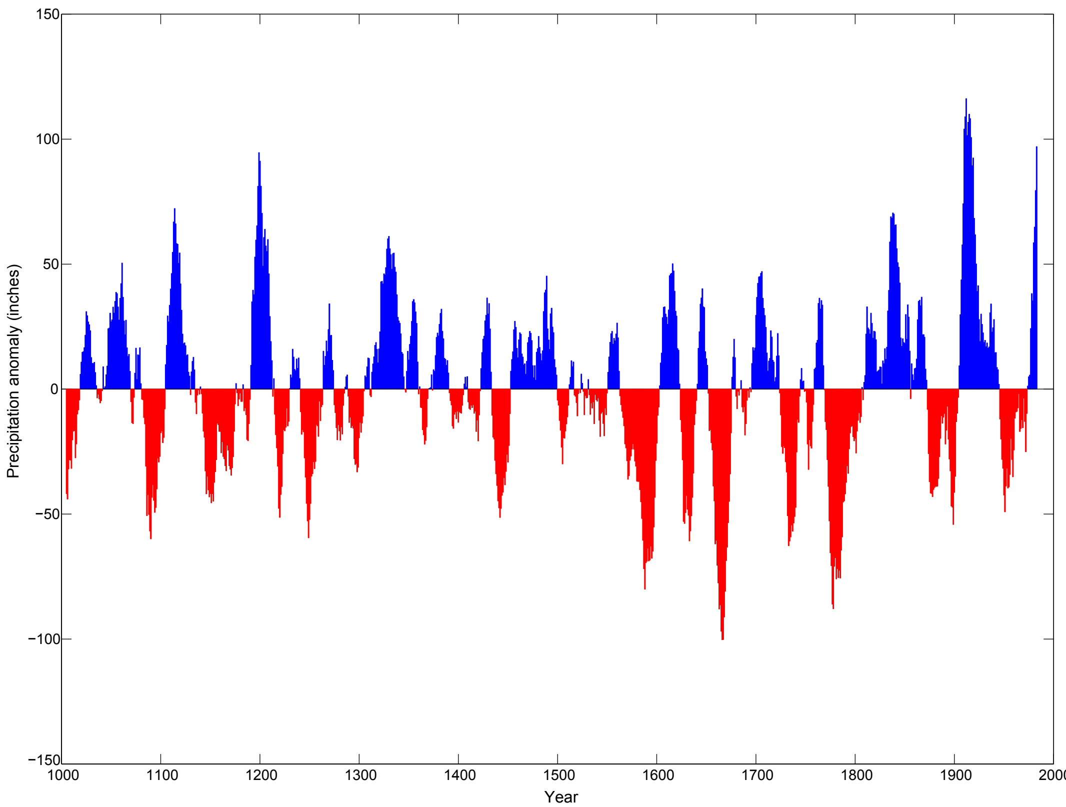


Data are from the U.S. Historical Climatology Network. Figure author: Ben Crawford, CLIMAS

During the summer monsoon thunderstorm season, atmospheric circulation shifts and brings moisture from the south and east to the planning area. Storms during this season are driven primarily by convection (heat-driven upward motion), aided by topography, which can force air parcels upward to heights where water vapor condenses. Summer convective thunderstorms tend to occur in spatially scattered cells. Many storms originate over the high elevations in the Central Highlands Planning Area and move downwards and outwards over the deserts. The planning area receives over 37% of its annual precipitation during July-September, which helps replenish streamflow and recharge groundwater aquifers, especially in the shallow fractured aquifers near Payson. However, summer precipitation is generally less hydrologically effective than winter precipitation because of greater evaporation rates and the spatial discontinuity of the storms.

An area-weighted average of tree-ring reconstructed winter (November-April) precipitation for Arizona Climate Division 3 (Yavapai County) and Arizona Climate Division 4 (Gila County) is representative of multi-year winter precipitation variations across the area (Figure 5.0-7). The record shows recurrent drought in each century, with notable winter dry periods in the mid-1100s, late 1500s, late 1670s, and late 1770s. Notable winter wet periods include the early 1200s, the late-1800s, and early 1900s. Precipitation variability on time scales of 10-30 years is likely related to shifts in Pacific Ocean circulation patterns, though recent research also points to the influence of the North Atlantic Ocean. Shorter-term variations (Figure 5.0-5) can be attributed to ocean-atmosphere variations related to the El Niño-Southern Oscillation. During El Niño episodes, there are greater chances for above-average winter precipitation, as storm tracks across North America are shifted farther south than normal. La Niña conditions are reliably associated with below-average winter precipitation.

Figure 5.0-7 Arizona NOAA Climate Divisions 3 & 4 winter (November-April) precipitation departures from average, 1000-1988, reconstructed from tree rings



Data are presented as a 20-year moving average to show variability on decadal time scales. Data: Fenbiao Ni, The University of Arizona Laboratory of Tree-Ring Research and CLIMAS. Figure author: Ben Crawford, CLIMAS

5.0.4 Environmental Conditions

Environmental conditions reflect the impacts of geography, climate and cultural activities and may be a critical consideration in water resource management and supply development. Discussed in this section is vegetation, riparian protection through the Arizona Water Protection Fund Program, instream flow claims, threatened and endangered species, public lands protected from development as national monuments, wilderness areas and preserves and unique and other managed waters.

Vegetation[3]

Three of Arizona's five ecoregions are included in the planning area: the Apache Highlands (north), which covers most of the area, the Sonoran Desert in the south, and the Arizona-New Mexico Mountains ecoregion stretching east-west at higher elevations along the Mogollon Rim, White Mountains and Flagstaff area. Because of the wide elevation range in the planning area, there are many biotic communities, ranging from Mohave desertscrub in the Upper Hassayampa Basin to subalpine grassland and subalpine conifer forest in the high elevations of the Salt River Basin and a very small area of alpine tundra above 12,000 feet on the San Francisco Peaks in the Verde River Basin. Much of the planning area is covered by interior chaparral and by great basin conifer woodlands.

The high elevation subalpine and montane conifer forests, consisting of dense stands of fir, spruce and aspen trees, receive much of their annual precipitation as snow. Because of the forest density, sunlight reaches the ground and snow melts slowly, releasing snowmelt gradually to streams. Snowfall accumulations in this area of the state are critical to the Phoenix metropolitan area water supply. Annual precipitation amounts are about 25 to over 30 inches a year in these areas.

Conifer woodlands consisting primarily of ponderosa pine occur at elevations between 6,000 and 9,000 feet that receive about 18 to 26 inches of annual precipitation. Piñon-juniper woodlands cover large areas below the ponderosa pine forest at elevations between 5,500 and 7,000 feet that receive 12 to 20 inches of precipitation. Below 6,800 feet there are more junipers than piñon pine and they may occur in pure stands.

Great Plains grasslands occur in several parts of the planning area at elevations between 5,000 and 7,000 feet that receive between 11 and 18 inches of annual precipitation. These areas are located primarily in Chino Valley and in small areas on the Fort Apache Indian reservation south of Fort Apache. The piñon-juniper woodland is often intermixed with this grassland.

At lower elevations (4,000-6,000 feet), interior chaparral is found in areas that receive 13 to 23 inches of annual precipitation. Chaparral consists of dense shrubs that grow around the same height with occasional taller shrubs or small trees. Chaparral communities typically are a mix of several shrubby species such as mountain mahogany, shrub live oak, and manzanita and commonly include cactus, agave, and yucca. Chaparral plants are well adapted to drought conditions.

Semi-desert grasslands occur in valleys between the desert and woodlands or chaparral at elevations

[3] Except as noted, information in this section is from Brown, D. and Lowe, C., 1980 and from AZGF, 2004.

between 3,500 and 5,000 feet that receive annual precipitation of 10 to 15 inches. Semi-desert grasslands are found in the Upper Hassayampa and Agua Fria basins and south of Payson in the Tonto Creek Basin. Desert grasslands often contain a mixture of grasses, shrubs and small trees.

Upper Sonoran desertscrub covers parts of the planning area below about 3,500 feet in the Upper Hassayampa, Agua Fria, Tonto Creek and Salt River basins. Typical vegetation includes palo verde, mesquite, creosote, and cacti, including Saguaro cacti.

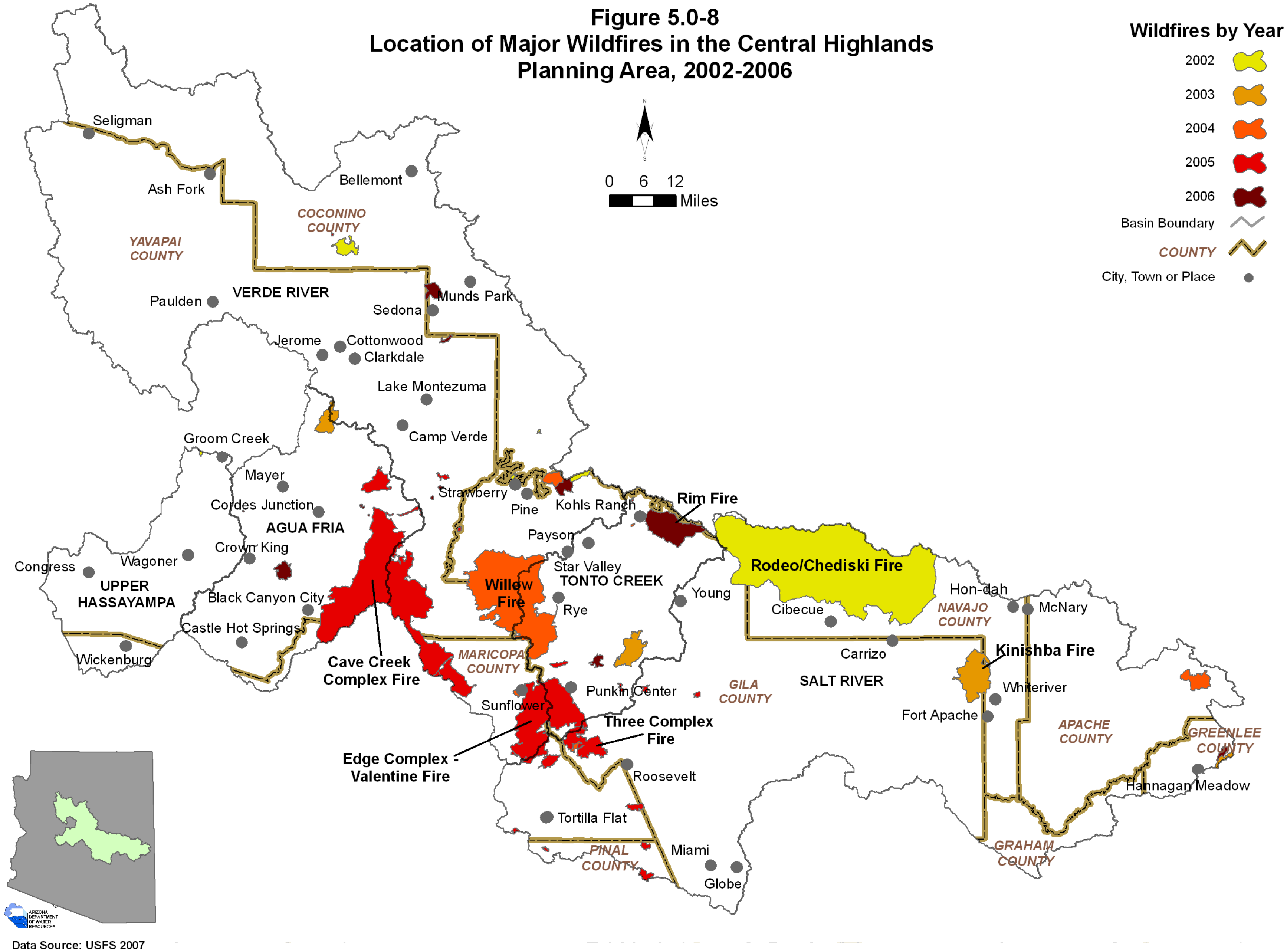
There are extensive reaches of riparian vegetation throughout the planning area. Along the Verde River and several tributary streams, riparian vegetation is composed of mixed broadleaf, cottonwood-willow, mesquite and strand vegetation (riparian obligate plants adapted to periodic flooding, scouring, or soil deposition). Conifer-Oak riparian obligate habitat is found at higher elevations in West Clear Creek and the East Verde River. Mixed broadleaf, mesquite and strand vegetation is found along the three perennial reaches of the Agua Fria River. Two tributaries to the Agua Fria River, Little Ash Creek and Sycamore Creek contain significant amounts of mixed broadleaf vegetation (NEMO, 2006). In the high elevation headwaters area of the Black River, riparian habitat is composed of wet meadow, mountain scrub and conifer-oak vegetation. Mixed broadleaf and strand vegetation are found along the Black River at lower elevations. Along the Salt River, riparian vegetation is composed of mesquite, strand and tamarisk at Roosevelt Lake. In the Tonto Creek Basin, mixed broadleaf, cottonwood-willow, strand and mesquite vegetation are found along Tonto Creek. Along the Hassayampa River at Wickenburg, riparian vegetation consists of cottonwood-willow, mesquite and strand while conifer-oak and mixed broadleaf are found at the Hassayampa River headwaters.

Several years of drought combined with high tree densities resulted in the largest outbreak of pine bark beetle populations ever recorded in Arizona during 2002 – 2004. This outbreak has killed millions of piñon and ponderosa pine trees. In 2003, bark beetle mortality was detected on about 763,000 acres in Arizona and New Mexico, with most of the mortality occurring in Arizona (USFS, 2003). Areas most affected were trees at the lower end of their elevational range. Drought conditions improved in 2004 and 2005, and mortality decreased substantially as a result of both higher precipitation and because many of the trees in the most susceptible areas were already dead.

Based on aerial surveys conducted in 2004 by the U.S. Forest Service, there were several areas of ponderosa pine infestation in the planning area. Areas with substantial bark beetle-caused ponderosa pine mortality occurred on parts of the Fort Apache Indian reservation, on lands west and north of the reservation, areas southwest of Bellemont, and areas west of Interstate 17 in the vicinity of Crown King. Data from aerial surveys recorded 2.1 million acres of piñon-juniper woodland and 1.3 million acres of ponderosa pine were affected in Arizona and New Mexico during 2002 – 2004 (USDA, 2007).

Wildfire risk increases with the number of dead trees in the landscape, which provide fuel for fires. There were several major wildfires in the Central Highlands Planning Area during the severe drought years between 2002 and 2005 (see Figure 5.0-8). The Rodeo-Chediski fire in 2002, Arizona's largest-ever, consumed about 462,600 acres, much of it in the north-central part of the Salt River Basin. The Willow Fire (2004) burned almost 120,000 acres southwest of Payson in the

Figure 5.0-8
Location of Major Wildfires in the Central Highlands Planning Area, 2002-2006



Tonto Creek and Verde River basins and the Cave Creek Complex (2005) burned 243,800 acres in the east-central part of the Agua Fria Basin and adjacent areas in the Verde River Basin and Phoenix AMA.

In the Southwest, fire can be among the most significant watershed disturbance agents, particularly to peak stream flows. In areas severely burned by the Rodeo-Chedeski Fire, peak flows were as much as 2,350 times greater than previously measured peak flows, the highest known post-fire peak flow in the Southwest. Increased peak flows can degrade stream channels and make them unstable, increase sediment production and cause flood damage. (Neary, D. et al, 2003) Drought, wildfire and long-term climate change involving warmer temperatures with earlier Springs and less snow cover could result in vegetative changes in the planning area with implications on runoff, infiltration and water supplies.

Arizona Water Protection Fund Programs

The objective of the Arizona Water Protection Fund Program (AWPF) program is to provide funds for protection and restoration of Arizona's rivers and streams and associated riparian habitats. Twenty-six riparian restoration projects in the Central Highlands Planning Area have been funded by the AWPF through 2005. Seventeen of these projects were funded in the Verde River Basin, primarily involving research, fencing and stream restoration on the Verde River. Four projects were funded in the Salt River Basin including restoration projects on Cherry Creek, Canyon Creek and at Lofer Cienega. Two stream restoration projects in the Agua Fria Basin on Ash Creek and Lynx Creek, and an erosion research and fencing and revegetation project in Dakini Valley in the Tonto Creek Basin have also been funded. In the Upper Hassayampa Basin, one project has been funded involving a constructed wetland. A list of projects and project types funded in the Central Highlands Planning Area through 2005 is found in Appendix A of this volume. A description of the program, a complete listing of all projects funded, and a reference map is found in Appendix C of Volume 1.

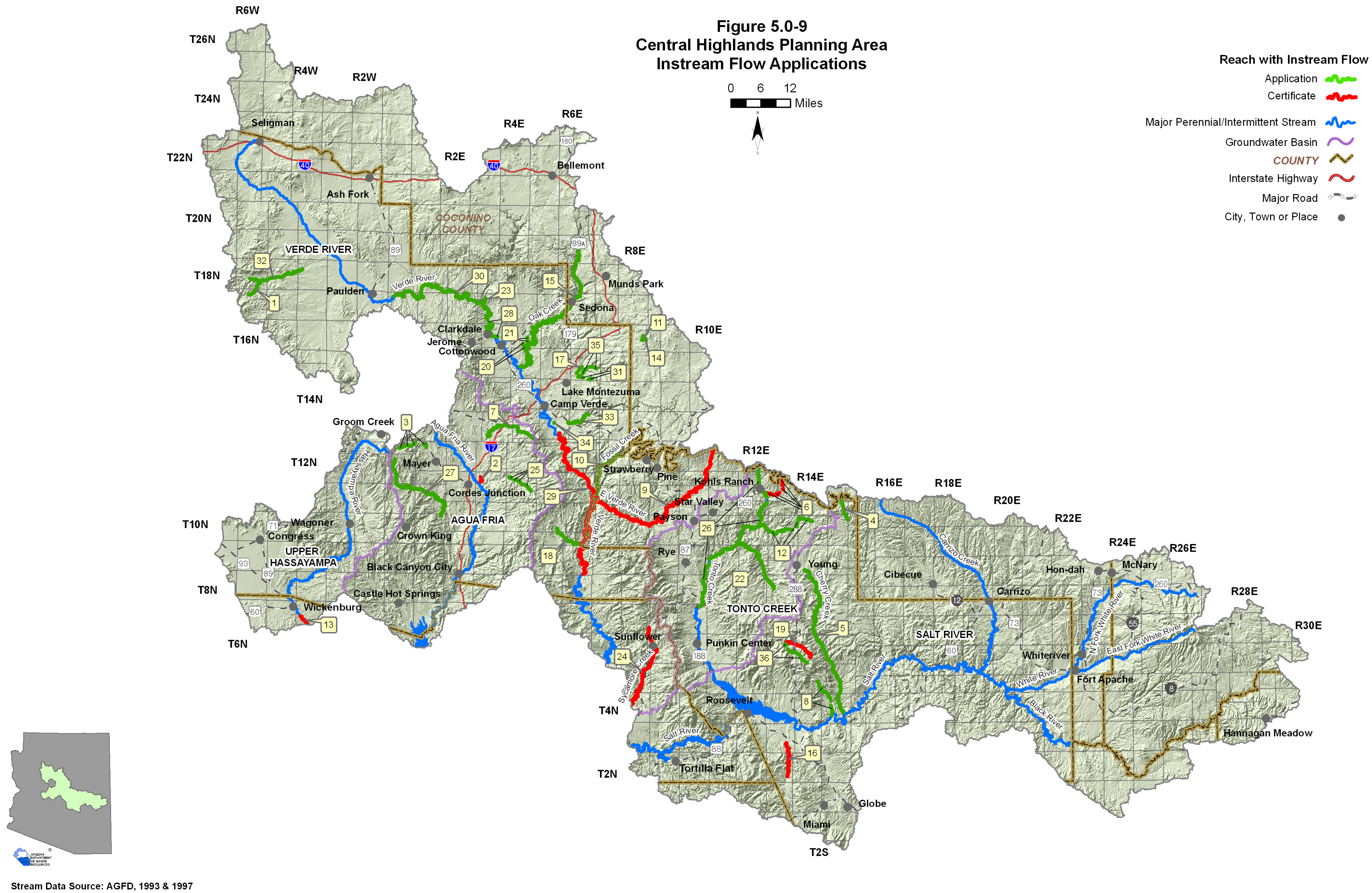
Instream Flow Claims

An instream flow water right is a non-diversionary appropriation of surface water for recreation and wildlife use. Thirty-six applications for instream flow claims have been filed in the Central Highlands Planning Area. The applications are listed in Table 5.0-1 and shown on Figure 5.0-9. Claims have been filed in all the basins in the planning area and eight certificates have been issued. Certificates have been issued for claims on Ash Creek in the Agua Fria Basin, Christopher Creek in the Tonto Creek Basin, the East Verde River, Sycamore Creek near Sunflower and the Verde River in the Verde River Basin, the Hassayampa River in the Upper Hassayampa River Basin, and Pinto Creek and Reynolds Creek in the Salt River Basin. Some of the certificates cover extensive reaches of rivers and streams as shown on Figure 5.0-9.

Table 5.0-1 Instream flow claims in the Central Highlands Planning Area

Map Key	Stream	Applicant	Application No.	Permit No.	Certificate No.	Filing Date
1	Apache Creek	Prescott National Forest	33-96801.0	Pending	Pending	7/22/2005
2	Ash Creek	BLM (Phoenix)	33-96411.0	96411	96411	1/5/1995
3	Big Bug Creek	Prescott National Forest	33-96802.0	Pending	Pending	7/22/2005
4	Canyon Creek	Tonto National Forest	33-96816.0	Pending	Pending	9/30/2005
5	Cherry Creek	Tonto National Forest	33-96609.0	Pending	Pending	6/30/1999
6	Christopher Creek	Tonto National Forest	33-96575.0	96575	96575	4/23/1998
7	Cienega Creek	Prescott National Forest	33-96803.0	Pending	Pending	7/22/2005
8	Coon Creek	Tonto National Forest	33-96742.0	Pending	Pending	6/18/2003
9	East Verde River	Tonto National Forest	33-90310.0	90310	90310	11/26/1985
10	Fossil Creek	Tonto National Forest	33-96622.0	Pending	Pending	12/1/1999
11	Foster Creek	Coconino National Forest	33-95370.0	Pending	Pending	2/2/1990
12	Haigler Creek	Tonto National Forest	33-96571.0	Pending	Pending	10/31/1997
13	Hassayampa River	Nature Conservancy	33-92304.0	92304	92304	1/20/1987
14	Jones Creek	Coconino National Forest	33-95371.0	Pending	Pending	2/2/1990
15	Oak Creek	Coconino National Forest	33-90106.0	Pending	Pending	7/29/1985
16	Pinto Creek	Tonto National Forest	33-89109.0	89109	89109	12/14/1983
17	Rarick Canyon	Coconino National Forest	33-90109.0	Pending	Pending	7/29/1985
18	Red Creek	Tonto National Forest	33-96743.0	Pending	Pending	6/18/2003
19	Reynolds Creek	Tonto National Forest	33-96570.0	96570	96570	10/31/1997
20	Sheepshead Creek	Coconino National Forest	33-90111.0	Pending	Pending	7/29/1985
21	Spring Creek	Coconino National Forest	33-90114.0	Pending	Pending	7/29/1985
22	Spring Creek	Tonto National Forest	33-96815.0	Pending	Pending	9/28/2005
23	Sycamore Creek	Coconino National Forest	33-90113.0	Pending	Pending	7/29/1985
24	Sycamore Creek	Tonto National Forest	33-96509.0	96509	96509	5/15/1996
25	Sycamore Creek	Prescott National Forest	33-96804.0	Pending	Pending	7/22/2005
26	Tonto Creek	Tonto National Forest	33-96684.0	Pending	Pending	11/15/2000
27	Turkey Creek	Prescott National Forest	33-96708.0	Pending	Pending	1/29/2002
29	Verde River	Tonto National Forest	33-90309.0	90309	90309	11/26/1985
30	Verde River	Prescott National Forest	33-94374.0	Pending	Pending	12/2/1988
28	Verde River	Phelps Dodge Corp.	33-96760.0	Pending	Pending	6/3/2004
31	Walker Creek	Coconino National Forest	33-90108.0	Pending	Pending	7/29/1985
32	Walnut Creek	Prescott National Forest	33-96800.0	Pending	Pending	7/22/2005
33	West Clear Creek	Coconino National Forest	33-90110.0	Pending	Pending	7/29/1985
34	West Clear Creek	Johnson, James A.	33-96178.0	Pending	Pending	3/20/1992
35	Wet Beaver Creek	Coconino National Forest	33-90112.0	Pending	Pending	7/29/1985
36	Workman Creek	Tonto National Forest	33-96618.0	Pending	Pending	10/26/1999

Figure 5.0-9
Central Highlands Planning Area
Instream Flow Applications



Threatened and Endangered Species

A number of listed threatened and endangered species may be present in the Central Highlands Planning Area. Those listed by the U.S. Fish and Wildlife Service (USFWS) as of May 2006 are shown in Table 5.0-2.[4] Presence of a listed species may be a critical consideration in water resource management and supply development in a particular area. The USFWS should be contacted for details regarding the Endangered Species Act (ESA), designated critical habitat and current listings.

Table 5.0.2 Listed threatened and endangered species in the Central Highlands Planning Area

Common Name	Threatened	Endangered	Elevation/Habitat
Apache (Arizona) Trout	X		>5000 ft./cold mountain streams
Arizona Agave		X	3,000 ft, steep, rocky granite slopes, or level hilltops, near chaparral; New River and Sierra Ancha Mountains
Arizona Cliff-rose		X	<4,000 ft./white soils of tertiary limestone lakebed deposits
Arizona hedgehog cactus		X	3,700-5,200 ft./ecotone between interior chapparal and madrean evergreen woodland
Bald Eagle	X		Varies/large trees or cliffs near water
California Brown Pelican		X	Varies/lakes and rivers
Chiricahua Leopard Frog	X		3,300-8,900ft./streams, rivers, backwaters, ponds stock tanks
Desert pupfish		X	<5,000 ft./shallow springs, small streams and marshes. Tolerates saline and warm water
Gila Chub		X	2,000-5,500 ft./pools, springs, cienegas and streams
Gila topminnow		X	<4,500 ft./small streams, springs and cienegas vegetated shallows

[4] An “endangered species” is defined by the USFWS as “an animal or plant species in danger of extinction throughout all or a significant portion of its range,” while a “threatened species” is “an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.”

Table 5.0.2 Listed threatened and endangered species in the Central Highlands Planning Area (Con't)

Common Name	Threatened	Endangered	Elevation/Habitat
Gila trout	X		5,000-10,000 ft./small, high mountain streams
Lesser long-nosed bat		X	<6,000 ft./desert scrub with agave and columnar cacti
Loach Minnow	X		<8,000ft./benthic species of small to large perennial streams
Mexican Gray Wolf		X	4,000-12,000 ft. /chapparal, woodland, forests
Mexican Spotted Owl	X		4,100-9,000 ft./canyons, dense forests with multi-layered foliage structure
Razorback sucker		X	<6,000 ft./riverine and lacustrine areas, not in fast moving water
San Francisco Peaks groundsel	X		>10,900 ft./Alpine tundra
Southwestern Willow Flycatcher		X	<8,500 ft./cottonwood-willow and tamarisk along rivers and streams
Spikedace	X		<6,000 ft./moderate to large perennial streams with gravel cobble substrates
Yuma Clapper Rail		X	<4,500 ft./Fresh water and brackish marshes

Source: USFWS 2006, CPC, 2007

In the Salt River watershed, SRP has developed the Roosevelt Habitat Conservation Plan (Plan) to minimize and mitigate the impacts of operation of Roosevelt Dam and Lake to the southwestern willow flycatcher, bald eagle, Yuma clapper rail, and western yellow-billed cuckoo (a candidate for ESA protection). Under the plan, SRP will acquire and protect at least 1,500 acres of riparian habitat in perpetuity along the San Pedro, Verde, and Gila rivers, or other river systems in Arizona, and implement other conservation measures to protect up to 750 additional acres of habitat. The Plan also includes rescue of bald eagle eggs and nestlings whose nests are threatened by inundation, monitoring of the species and habitat at Roosevelt Lake and in the mitigation areas, and other measures. Following SRPs commitment to implementation of the Plan, the U.S. Fish and Wildlife Service issued a 50-year permit to SRP to "take" endangered southwestern willow flycatchers, threatened bald eagles, endangered Yuma clapper rails, and candidate yellow-billed cuckoos incidental to operation of Roosevelt Dam and Lake. SRP is also working on a Habitat Conservation Plan for operation of Horseshoe and Bartlett dams and reservoirs but the plan is still in production and under negotiation.

National Monuments, Wilderness Areas and Preserves

Four national monuments that protect prehistoric dwellings are located in the planning area. Montezuma Castle, Tonto and Tuzigoot National Monuments are small sites containing cliff dwellings or pueblos. Tonto National Monument is located along Tonto Creek in the Salt River Basin while the others are located in the Verde Valley in the Verde River Basin. Agua Fria National Monument, administered by the Bureau of Land Management, covers 71,700 acres in the Agua Fria Basin (see Figure 5.1-2). It contains at least 450 prehistoric sites, four major settlement areas, and the Agua Fria River canyon, which contains a perennial reach of the river.

All or portions of 21 Wilderness Areas, encompassing 788,000 acres, are found within the planning area. Wilderness Areas are designated under the 1964 Wilderness Act to preserve and protect the designated area in its natural condition. Designated areas, their size, basin location and a brief description of the area are listed in Table 5.0-3. All wilderness areas are located on National Forest Service lands with the exception of the Hassayampa River Canyon Wilderness which is administered by the Bureau of Land Management. Most of the wilderness areas protect riparian habitat, rivers and streams and are located in the Verde River Basin.

The Hassayampa River Preserve in the Upper Hassayampa Basin just south of Wickenburg, was established in 1986 by The Nature Conservancy. The preserve protects spring-fed Palm Lake, a four-acre pond and marsh habitat that attracts water birds and provides habitat for endangered fish. The Hassayampa River is perennial within the preserve and supports lush streamside habitat.

Unique and Other Managed Waters

Several "unique waters", designated by the Arizona Department of Environmental Quality (ADEQ) pursuant to A.C.C. R18-11-112, as having exceptional recreational or ecological significance and/or providing habitat for threatened or endangered species, have been identified in the planning area. These include:

- Oak Creek, including the West Fork of Oak Creek in the Verde River Basin
- Snake Creek, from its headwaters to its confluence with the West Fork of the Black River in the Salt River Basin
- Hay Creek, from its headwaters to its confluence with the West Fork of the Black River in the Salt River Basin
- Stinky Creek, from the Fort Apache Indian Reservation boundary to its confluence with the West Fork of the Black River in the Salt River Basin
- Bear Wallow Creek, from its headwaters to the boundary of the San Carlos Indian Reservation in the Salt River Basin.

Table 5.0-3 Wilderness Areas in the Central Highlands Planning Area

Wilderness Area	Acres	Basin	Description
Apache Creek	5,488	Verde River	Three springs and important riparian area including Apache Creek
Bear Wallow	11,336	Salt River (part)	Alpine forest of mixed conifers and aspens. Bear Wallow drainage with rich streamside habitat.
Castle Creek	25,536	Agua Fria	Bradshaw Mountains, prominent granite peaks, vegetation range from saguaro to pine
Cedar Bench	16,127	Verde River	Located along Verde Rim, borders portion of Verde Wild and Scenic River
Fossil Creek	10,400	Verde River	Extremely diverse riparian area, 1,600 foot deep canyon, travertine deposits, springs
Granite Mountain	9,747	Verde River	Mountain characterized by granite boulders, some the size of a house, stacked one atop the other to elevations that exceed 7,600 feet.
Hassayampa River Canyon	11,840	Upper Hassayampa	Includes several miles of the Hassayampa River and riparian habitat.
Hellsgate	37,399	Tonto Creek	Major canyon, Tonto Creek with deep pools of water and impassable falls
Juniper Mesa	7,708	Verde River	Flat topped mesa, great variety of wildlife
Mazatzal	250,053	Verde River, Tonto Creek	Mazatzal mountains, chaparral and pine vegetation with narrow, vertical walled canyons. Includes portion of Verde Wild and Scenic river
Munds Mountain	18,069	Verde River	Munds and Lee mountains, Jacks, Woods and Rattlesnake canyons, Courthouse Butte and Bell Rock
Pine Mountain	20,100	Agua Fria, Verde River	Island of tall timber, surrounded by brush-covered desert mountains with hot, dry mesas and deep canyons.
Red Rock Secret Mountain	48,263	Verde River	Red rock pinnacles, arches and slot canyons, rock art and prehistoric dwellings
Salome	18,515	Salt River	Upper/perennial reaches of Salome Creek and Workman Creek
Salt River Canyon	32,088	Salt River	Portions of the Salt River and spectacular canyon
Sierra Ancha	21,007	Salt River	Box canyons, high cliffs, prehistoric dwellings
Superstition	160,135	Salt River (part)	Rugged mountains, rock formations, large vegetation range, prehistoric dwellings, riparian habitat.
Sycamore Canyon	57,916	Verde River	Large canyon with desert riparian area. Extends from near Williams to Verde Valley
West Clear Creek	15,267	Verde River	Deep, narrow canyon with many pools of water
Wet Beaver Creek	6,178	Verde River	Major canyon in red rock rim country
Woodchute	5,553	Agua Fria	Views, ponderosa pine, pinon and juniper
Total Acres in Planning Area	788,000		

Source: BLM 2006, USFS 2007

In 2004, Arizona Public Service Company surrendered a license from the Federal Energy Regulatory Commission to operate hydroelectric power plants at Irving and Childs on Fossil Creek in the Verde River Basin near Strawberry. As part of the decommissioning they agreed to remove project features and restore the landscape. These two historic power plants were constructed beginning in 1908 and operated by turbines driven by water diverted from Fossil Creek. This diversion captured most of the natural spring fed flow of the creek and fundamentally changed the character of the stream. The springs that supply the base flow of Fossil Creek are rich in calcium carbonate that precipitates out and forms travertine dams. Absent the natural flow and travertine deposition, the stream was no longer a series of pools impounded by travertine dams. Following restoration of flow, native fish were removed and non-native fish eradicated from the stream in order to reestablish fish native to the system.

Stillman Lake is a narrow 20-acre impoundment located above a natural sediment dam at the headwaters of the Verde River south of Paulden and below Sullivan Dam in the Verde River Basin. The Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and the Bureau of Reclamation are working together to manage Stillman Lake for native fish by eliminating non-native species. Arizona Game and Fish currently owns and manages several parcels of river bottom land downstream from Sullivan Dam to maintain habitat for sensitive species of fish and wildlife (USFWS, 2007).

Congress adopted the Wild and Scenic Rivers Act in October 1968 to preserve selected rivers that possess "outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural or other similar values" in their free-flowing condition for the benefit of present and future generations. About 40 miles of the 170-mile long Verde River has been designated a National Wild and Scenic River, the only one in Arizona. The Scenic River Area begins about six miles south of Camp Verde and extends to the boundary of the Mazatzal Wilderness in T11N, R6E; a reach of 18.3 miles. The Wild River Area begins below the Scenic River Area and continues for 22.2 miles to its confluence with Red Creek within section 34, T9½N, R6E (see Figure 5.5-4). Under the Act the river area must be managed in a manner that protects and enhances its "outstandingly remarkable values" (NWSR, 2007)

5.0.5 Population

Census data for 2000 show about 145,850 residents in the Central Highlands Planning Area. Arizona Department of Economic Security (DES) population projections forecast that the planning area population will almost double by 2050, to about 264,600 residents. Historic, current and projected basin population is shown in the basin cultural water demand tables.

The most populous basin by far as reported in the 2000 Census is the Verde River Basin with more than 88,000 residents or 62% of the planning area total. The 2003 estimated population of the Verde River Basin is over 93,000 residents. The 2000 Census populations for each basin and Indian reservation, listed from highest to lowest, are shown in Table 5.0-4.

Table 5.0-4 2000 Census population of basins and Indian reservations in the Central Highlands Planning Area

Basin/Reservation	2000 Census Population
Verde River	88,242
Yavapai-Apache	*743*
Salt River	31,381
Fort Apache	*10,385*
San Carlos Apache	*Unk* [1]
Upper Hassayampa	10,479
Agua Fria	8,210
Tonto Creek	7,537
Tonto Apache	*132*

[1] Almost the entire San Carlos Apache Reservation population is located in the Southeastern Arizona Planning Area.

Shown in Table 5.0-5 are incorporated and unincorporated communities in the planning area with 2000 Census populations greater than 1,000 and growth rates for two time periods. Communities are listed from highest to lowest population in 2000 and their location is shown on Figure 5.0-10. The planning area population grew by 35% between 1990 and 2000. A number of communities lack data for 1990, but it appears that there has been considerable growth in smaller communities in the planning area. Of note is the large number of communities in this planning area with populations between 1,000 and 5,000. Many of these smaller communities are "satellite" communities of nearby incorporated areas; e.g. Kachina Village, Munds Park, Parks and Mountainaire are all located near Flagstaff, just outside of the planning area. There were eight incorporated communities within the planning area in 2000. The community of Star Valley, east of Payson, incorporated in 2005 due to concerns that the Town of Payson would take water from the Star Valley area to serve new developments (Payson Roundup, 2005). Payson is the largest community in the planning area with 13,620 residents, followed by Sedona, Camp Verde, Cottonwood, Globe, Wickenburg, and Miami.

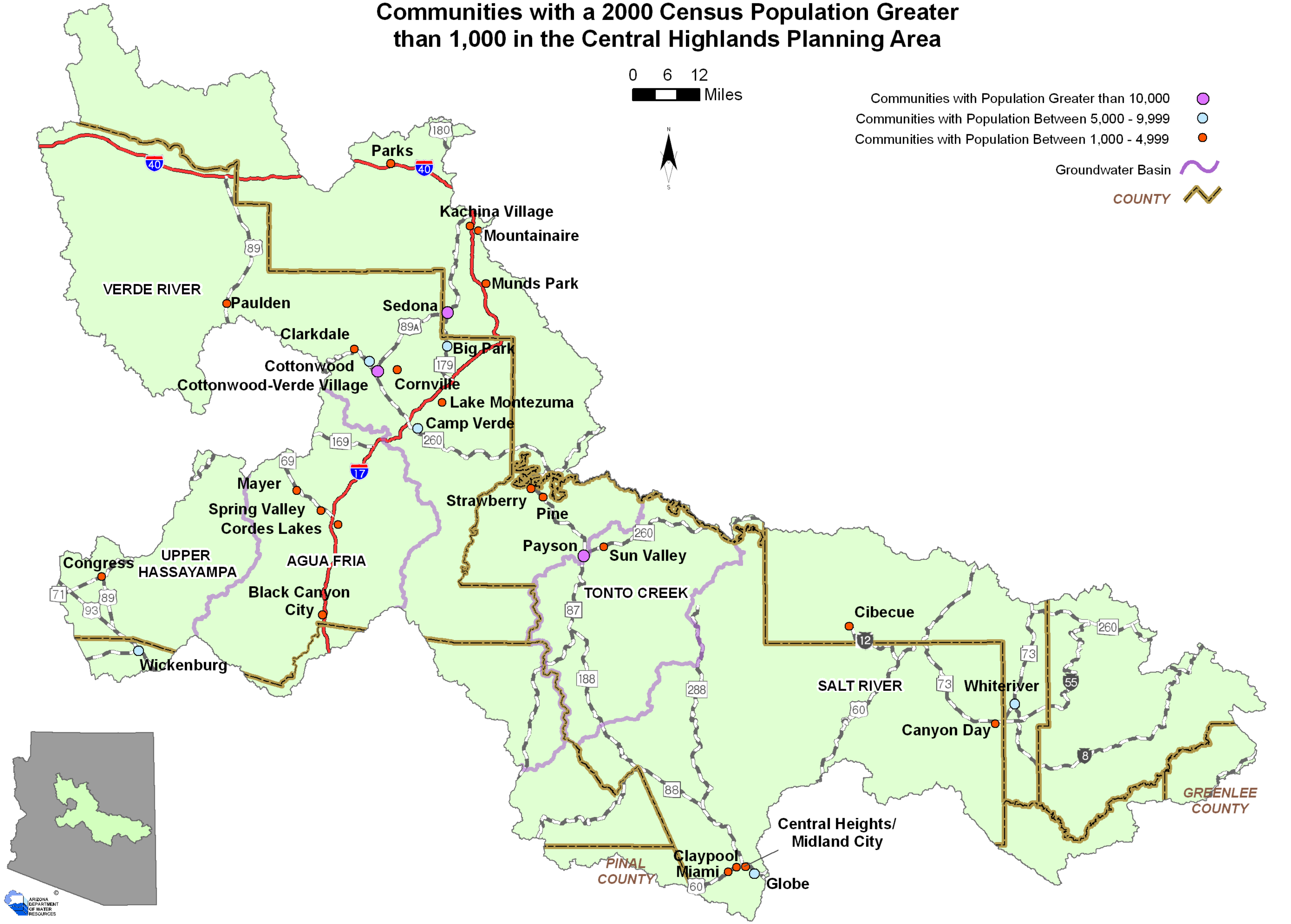
Rapid growth is occurring in several areas including near Prescott and Flagstaff, Sedona, Payson and the Verde Valley communities of Cottonwood, Camp Verde, Clarkdale and Cornville. The Verde Valley area population represents about 32% of the population of Yavapai County (Dava & Associates, 2003). Between 2000 and 2005, the community of Wickenburg grew by 30%, the fastest growth rate reported in the planning area. Population projections for 2050 are not currently available for a number of communities, including Wickenburg, however, the population of the planning area is projected to increase by at least 85% by 2050. The median age in many

Table 5.0-5 Communities in the Central Highlands Planning Area with a 2000 Census population greater than 1,000

Communities	Basin	1990 Census Pop.	2000 Census Pop.	Percent Change 1990-2000	2005 Pop. Estimate	Percent Change 2000-2005	Projected 2050 Pop.
Payson*	Verde River	8,377	13,620	63	15,430	13	29,444
Cottonwood-Verde Village	Verde River	7,037	10,610	51	NA	NA	10,905
Sedona*	Verde River	7,720	10,192	32	10,935	7	19,591
Camp Verde*	Verde River	6,243	9,451	51	10,730	14	19,300
Cottonwood*	Verde River	5,918	9,179	55	10,860	18	24,109
Globe*	Salt River	6,062	7,486	23	7,495	0	9,827
Big Park	Verde River	3,034	5,245	73	NA	NA	11,363
Whiteriver	Salt River	3,775	5,220	38	NA	NA	9,181
Wickenburg*	Upper Hassayampa	4,515	5,082	13	6,590	30	NA
Clarkdale*	Verde River	2,144	3,422	60	3,680	8	6,571
Paulden	Verde River	NA	3,420	NA	NA	NA	NA
Lake Montezuma	Agua Fria	1,841	3,344	82	NA	NA	4,969
Cornville	Verde River	2,089	3,335	60	NA	NA	7,300
Black Canyon City	Agua Fria	1,811	2,697	49	NA	NA	4,939
Central Hts./Midland City	Salt River	2,969	2,694	-9	NA	NA	4,339
Kachina Village	Verde River	1,711	2,664	56	NA	NA	4,397
Cordes Lakes	Agua Fria	NA	2,058	NA	NA	NA	NA
Miami*	Salt River	2,018	1,936	-4	1,955	NA	2,196
Pine	Verde River	NA	1,931	NA	NA	NA	NA
Claypool	Salt River	1,942	1,794	-8	NA	NA	2,226
Congress	Upper Hassayampa	NA	1,717	NA	NA	NA	NA
Mayer	Agua Fria	NA	1,408	NA	NA	NA	2,286
Sun Valley	Tonto Creek	NA	1,536	NA	NA	NA	NA
Cibecue	Salt River	1,254	1,331	6	NA	NA	2,873
Munds Park	Verde River	NA	1,250	NA	NA	NA	2,802
Parks	Verde River	NA	1,137	NA	NA	NA	2,701
Canyon Day	Salt River	857	1,092	27	NA	NA	1,299
Strawberry	Verde River	NA	1,028	NA	NA	NA	NA
Spring Valley	Agua Fria	NA	1,019	NA	NA	NA	NA
Mountainaire	Verde River	NA	1,014	NA	NA	NA	1,646
Total >1,000		71,317	117,912	65	NA	---	
Other		34,110	24,938	-27	NA	---	
Total		**105,427**	**142,850**	35	NA	---	**264,648**

Source: DES, 2005: www.workforce.az.gov, U.S. Census Bureau, 2006
Notes: 2005 population estimates not available for unincorporated communities
NA = not available
* = incorporated communities

Figure 5.0-10
Communities with a 2000 Census Population Greater than 1,000 in the Central Highlands Planning Area



communities is considerably older than the state average of 34.2 years. Sedona, Congress, Big Park, Black Canyon City, and Clarkdale have median ages of over 45.

Population Growth and Water Use

The state has limited mechanisms to address the connections between land use, population growth and water supply. A legislative attempt to link growth and water management planning is the Growing Smarter Plus Act of 2000 (Act) which requires that counties with a population greater than 125,000 (2000 Census) include planning for water resources in their comprehensive plans. Yavapai, Maricopa and Pinal counties fit the population criteria. There is relatively little population or water development within the Maricopa and Pinal county sections of the planning area. About 4,800 square miles (35%) of Yavapai County is located within the planning area, the largest area of any of the nine counties located within it. The Yavapai County water resources element includes an overview of the watersheds in the county, a statement of goals and objectives regarding water supply, water quality and protection of water resources, and an evaluation of existing water use data. Also included is a discussion of the Yavapai County Water Advisory Committee (WAC), a group tasked with development of a regional water management strategy which helps support the water resource goals in the general plan. (Dava & Associates, Inc., 2003).

The Act also requires that twenty-three communities outside AMAs include a water resources element in their general plans. In the Central Highlands Planning Area this requirement applies to the communities of Camp Verde, Clarkdale, Cottonwood, Globe, and Sedona. As of June, 2007, all communities but Globe had completed a water resource element. Plans must consider water demand and water resource availability in conjunction with growth, land use and infrastructure. References to completed plans are listed in basin references in this volume and may contain useful information for water resource planning.

Beginning in 2007, all community water systems in the state are required to submit Annual Water Use Reports and System Water Plans. The reports and plans are intended to reduce community water systems' vulnerability to drought, and to promote water resource planning to ensure that water providers are prepared to respond to water shortage conditions. In addition, the information will allow the State to provide regional planning assistance to help communities prepare for, mitigate and respond to drought. An Annual Water Use Report will be submitted each year by the systems, beginning June 1, 2007, and include information on water pumped or diverted, water received, water delivered to customers, and effluent used or received. The System Water Plan will be updated and submitted every five years and will consist of three components, a Water Supply Plan, a Drought Preparedness Plan and a Water Conservation Plan. Systems that serve populations greater than 1,850 were required to submit plans by January 1, 2007. Systems that serve populations less than 1,850 are required to submit plans by January 1, 2008. Plans have been submitted by most of the larger systems in the planning area and were used to prepare this document.

The Department's Water Adequacy Program also connects water supply and demand to growth to some extent, but does not control growth. Developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents. Legislation adopted in June, 2007 (SB 1575), authorizes a county board of supervisors to adopt a provision, by unanimous vote, which requires a new subdivision to have an adequate water supply in order for the subdivision to be approved by the platting authority. If the county does not adopt the provision, the legislation allows a city or town to adopt a local adequacy ordinance that requires a demonstration of adequacy. Subdivision adequacy determinations (Water Adequacy Reports), including the reason for the inadequate determination, are provided in the basin sections of this volume and are summarized for each basin in Table 5.0-6.

Table 5.0-6 Water Adequacy Determinations in the Central Highlands Planning Area as of 5/2005

Basin	Number of Subdivisions	Number of Lots[1]	Adequate	Inadequate	Approx. Percent Inadequate
Agua Fria	15	>1,177	>973	204	17%
Salt River	17	>968	106	>862	89%
Tonto Creek	54	>3,686	>352	>3,334	90%
Upper Hassayampa	26	>1564	>1,225	339	22%
Verde River	375	>29,505	>22,578	>6,927	23%
TOTAL	**487**	**>36,900**	**>25,234**	**>11,666**	**48%**

Source: ADWR 2006a
Notes:
[1] Data on number of lots are missing for some subdivisions; actual number is larger

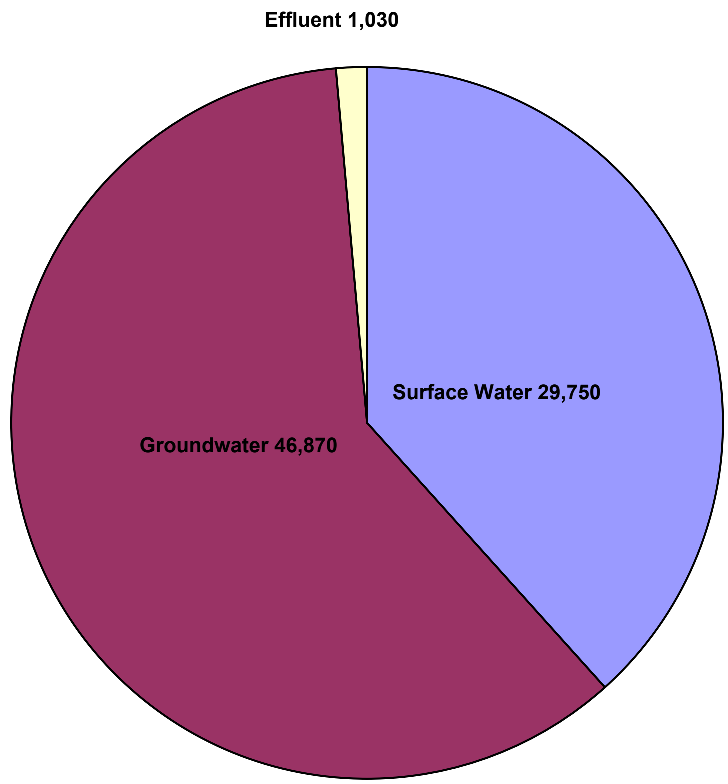
The service areas of six water providers in the planning area have been designated as having an adequate water supply. If a subdivision is served by one of these designated water providers, a separate adequacy determination is not required. As of January 1, 2007 these included:

- City of Globe
- Town of Wickenburg
- Little Park Water Company-Village of Oak Creek
- Big Park Water Company-Village of Oak Creek
- American Ranch Domestic Water Improvement District – American Ranch Development near Prescott
- Verde Santa Fe Water Company-Verde Santa Fe Development at Cornville

5.0.6 Water Supply

Water supplies in the Central Highlands Planning Area include groundwater, surface water and effluent. Central Arizona Project (CAP) water diverted from the Colorado River via the CAP canal is stored in the planning area but is not utilized within it. Groundwater is the primary water supply, accounting for about 61% of the demand. Surface water is used extensively for agricultural irrigation in the Verde River Basin and to some extent in the Salt River Basin where it is also used to meet mining demand. It is estimated that about 38% of the total water demand is met with surface water. Effluent is utilized for golf course irrigation in the Tonto Creek and Verde River basins, contributing 1% of the planning area's water supply. For purposes of the Atlas, water diverted from a watercourse or spring is considered surface water and if it is pumped from wells, it is accounted for as groundwater. This is reflected in the cultural water demand tables in each basin section.

Figure 5.0-11 Water Supplies Utilized in the Central Highlands Planning Area in acre-feet (average annual use 2001-2003)



Central Arizona Project Water

New Waddell Dam, located on the Agua Fria River in the Phoenix Active Management Area, stores Central Arizona Project (CAP) water in Lake Pleasant located in the Agua Fria Basin. This water is not a direct supply for the planning area. The dam also stores Agua Fria River water and provides flood control. In the winter, water is pumped from the CAP canal to Lake Pleasant. When demand increases in the summer, water is released through the same canal to downstream CAP contractors within the Central Arizona Water Conservation District service area, Maricopa, Pima and Pinal counties.

Six municipal and industrial water providers and/or water users and three Indian tribes located in the Central Highlands Planning Area, listed in Table 5.0-7, were allocated an entitlement of CAP water. To physically acquire water under their respective subcontracts, it was anticipated that subcontractors located outside of the CAP service area would exchange their CAP entitlement for a locally available surface water supply that was held by a downstream senior water right holder located within the CAP service area. The CAP entitlements held by Indian Tribes could also be included in any future, potential water settlement.

Due to environmental issues associated with the potential exchange of its CAP entitlement for East Verde River water rights held by SRP, the town of Payson chose to sell its CAP entitlement to the City of Scottsdale. The transfer process was completed in 1994. The money acquired from the sale was deposited into a trust fund managed by the U.S. Bureau of Reclamation for the purpose of developing alternative water supplies for Payson.

In response to the proposed transfer of Payson's CAP subcontract to Scottsdale, the Department developed a transfer policy to govern the transfer of a CAP entitlement from a subcontractor located outside of the CAP service area. Subsequent to the adoption of this policy, Camp Verde Water System, Inc., Cottonwood Water Works, Inc., and the Mayer Domestic Water Improvement District decided to transfer their subcontracts to Scottsdale. Monies resulting from the sale of these entitlements were also placed in separate trust fund accounts for each entity. Table 5.0-7 identifies the entitlement volumes that were eventually transferred to Scottsdale and the gross proceeds that resulted from the respective transactions.

Table 5.0-7. CAP Subcontractors and Transferred Entitlements in the Central Highlands Planning Area

CAP Subcontractor	CAP Entitlement (Acre-Feet)	CAP Entitlement Transfered	Gross Proceeds from Transfer[1]
Camp Verde Water System, Inc.	1,443	1,443	1,443,000
Cottonwood Water Works Inc.	1,789	1,789	1,789,000
Mayer Domestic Water Improvement District	332	332	332,000
Town of Payson	4,995	4,995	4,995,000
Phelps Dodge Miami, Inc.	2,916		
Pine Water Co.	161		
San Carlos Apache Tribe	61,645		
Tonto Apache - Indian Tribe	128		
Yavapai-Apache Tribe	1,200		

[1] Does not reflect the reduction associated with equivalency charges and capital costs due to CAWCD or other fees associated with the entitlement transfer actions.

In accordance with each trust fund agreement, the Department provides oversight regarding expenditures from these accounts to ensure that trust fund monies are used to defray expenses associated with "designing, constructing, acquiring and/or developing an alternative water supply in an amount which may include, but is not limited to, a combined net increase" in the subcontractor's "water system capacity to replace the CAP allocation" that it sold.

Plans regarding the CAP entitlements held by Phelps Dodge Miami, Inc and Pine Water Company are not known. The San Carlos Apache Tribe leases a portion of its CAP allocation to the City of Scottsdale and as exchange water for use by Phelps Dodge at Morenci in the Southeastern Arizona Planning Area. The Tonto-Apache Tribe and the Yavapai-Apache have no current uses or exchanges.

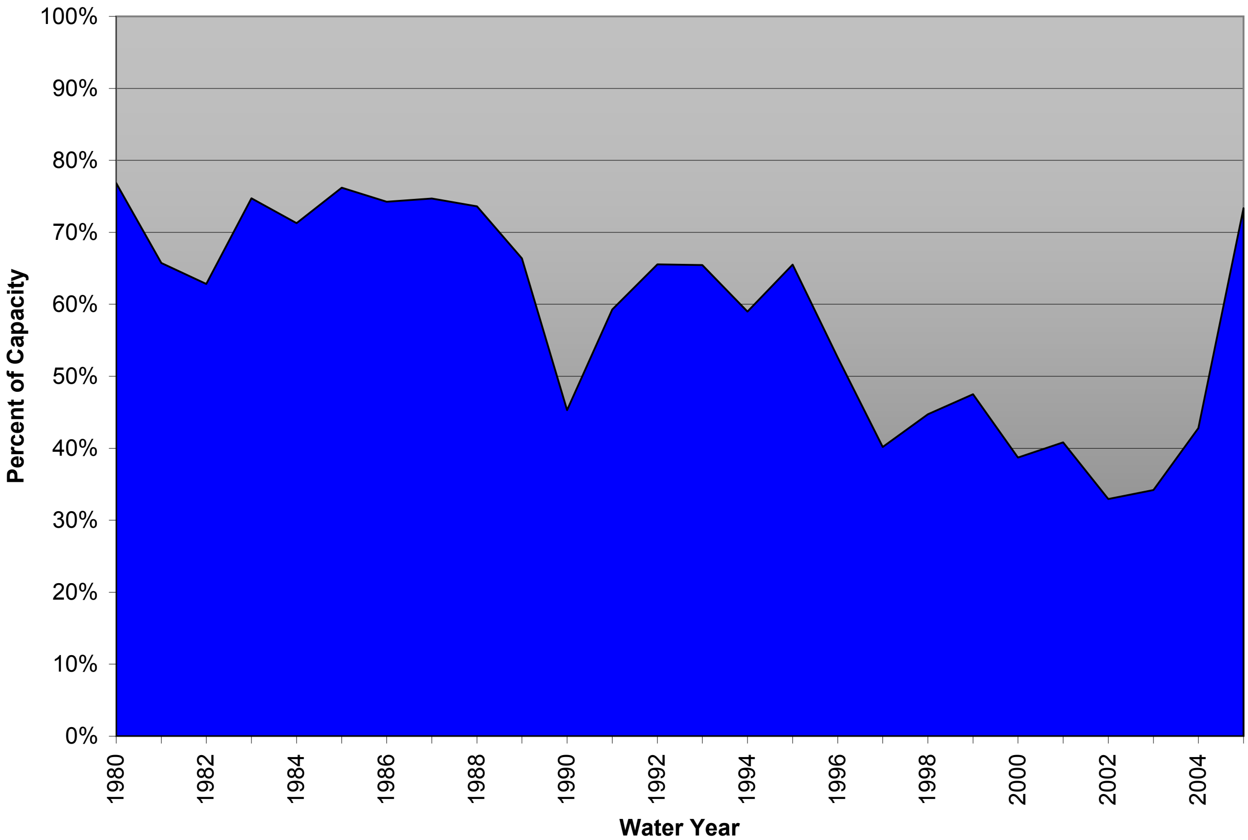
Of interest to the Central Highlands Planning Area are the CAP entitlements held by Prescott and the Yavapai-Prescott Indian Tribe that were transferred to Scottsdale under the Yavapai-Prescott Indian Tribe Water Rights Settlement Act of 1994 (Act). The proceeds acquired from the entitlement transfer actions were deposited into the Verde River Basin Fund. In accordance with Section 106.c of the Act, the Secretary of the Interior (Secretary) is directed to make payments from the fund to Prescott "for the exclusive purpose of acquiring, investigating and developing an alternative water supply consistent with the goal of the Prescott AMA and preservation of the riparian habitat, flows and biota of the Verde River and its tributaries". Section 107.a of the Act states that monies can be used by Prescott "for purposes of defraying expenses associated with the investigation, acquisition or development of alternative source of water to replace the CAP water relinquished under this title. Alternative sources shall be understood to include, but not be limited to, retirement of agricultural land and acquisition of associated water rights, development of groundwater resources outside of the PAMA [Prescott AMA] and artificial recharge…".

Surface Water

The Salt and Verde Rivers, and the Gila River to the south, are the primary in-state sources of surface water in Arizona. Relatively high elevations along the Mogollon Rim and in the White Mountains with associated high amounts of rainfall and snowfall make the Salt and Verde watersheds extremely productive. However, because flows in the Salt and Verde Rivers are strongly influenced by precipitation and topography, surface water flows and water levels in reservoirs along the rivers can fluctuate widely due to climate variations. Surface water is an important supply for cultural water uses in the Salt River, Tonto Creek and Verde River basins where it also supports extensive riparian habitat.

The Salt and Verde River reservoirs and dams are operated by SRP to store and release water for the benefit of agricultural, municipal and industrial users in the Phoenix metropolitan area. These supplies are generally not available for use in the planning area except for small amounts used for recreation and other purposes at each reservoir. The water stored in the Salt River reservoir system illustrates the relationship between downstream water demand and precipitation and snowfall in the watershed. As shown in Figure 5.0-12, storage has fluctuated widely over the past ten years as water is collected or released to meet water demands. Shown is the impact of severe drought conditions during 2002 and storage recovery in 2005 following a wet winter. As of June 1, 2007, storage in the Salt system was 60% of capacity.

Figure 5.0-12 Water Stored in Salt River System Reservoirs, 1980-2005



Source: USGS 2007

Upstream of the reservoirs, surface water is primarily diverted for irrigation from Tonto Creek and its tributaries and along the Salt River. At elevations above 4,000 feet, surface water from springs and streams supply small irrigated parcels (ADWR, 1992). It is not known if surface water availability has been an issue for surface water users upstream of Roosevelt Dam during periods of drought.

A relatively small amount of surface water is diverted from Pinal Creek for operations at the Miami Mine in the Salt River Basin. Surface water may be diverted from Pinto Creek to support future mining operations at the nearby Pinto Valley Mine, slated to reopen in Fall, 2007. The Carlota Mine located north of the Pinto Valley Mine along Pinto Creek is projected to open in 2008. It is not known whether surface water will be used to supply the operation.

Pursuant to complex exchange agreements with the San Carlos Apache Tribe, SRP and the Central Arizona Project, Phelps Dodge diverts surface water from the Black River in the Salt River Basin for use at the Morenci Mine in the Southeastern Arizona Planning Area. To compensate downstream water users for diversions from the Black River, Phelps Dodge historically diverted water into the

Central Highlands Planning Area from two locations in the Little Colorado River Basin, Show Low Lake and Blue Ridge Reservoir (now C.C. Cragin). Water demand tables in Volume 5 take into account both the water removed from and replaced into the Salt River Basin. Because water diverted from Blue Ridge Reservoir passes through the Verde River Basin (via East Verde River) and is not used in the basin, it is not reflected in the surface water use estimated for the Verde River Basin.

The Phelps Dodge surface water diversions to the Morenci Mine are located at the Black River Pump Station and conveyed over the Natanes Plateau and into Willow Creek. In 2003, approximately 6,450 acre-feet were diverted from the Black River for this purpose.

C.C. Cragin reservoir, located in the Eastern Plateau Planning Area approximately 25 miles north of Payson, was acquired by SRP from Phelps Dodge Corporation in February 2005 as part of the Arizona Water Settlement Act (Act). The reservoir satisfies obligations to the Gila River Indian Community, and will be used to supplement SRP's water supply and to assist in improving the water supply situation in northern Gila County in accordance with the Act (SRP, 2007). The Town of Payson is pursuing a long-term agreement with SRP to utilize a portion of the water stored at C.C. Cragin Reservoir as a water supply for the town. This will require construction of a pipeline and a water storage mechanism.

The Verde River system reservoirs are smaller that those on the Salt with average annual inflows exceeding their storage capacity. Consequently, the reservoirs are managed to minimize the potential for spill during the winter months, with releases of water during the fall, winter and spring (Ester and Reigle, 2001). Storage volumes in the Verde River reservoirs, particularly in Horseshoe Lake, have been reduced to almost zero at times during recent drought years. As of June 1, 2007, storage in Horseshoe Lake was 3% of capacity and storage in the total Verde system was 27% of capacity.

Surface water is diverted from the Verde River for agricultural use primarily in the Verde Valley Sub-basin of the Verde River Basin. Most farming occurs within the younger alluvium along the river. There are currently about 30 irrigation diversions in the Verde Valley. During periods of drought, surface water shortfalls are met by groundwater pumping. Reportedly, a small volume of surface water is utilized at higher elevations in the Big Chino Valley. (ADWR, 2000)

Arizona Revised Statutes (A.R.S. 45-555) allow the transportation of groundwater pumped from the Big Chino Sub-basin into the Prescott AMA. There are concerns that increased groundwater withdrawals in this sub-basin may contribute to reduced flows in the headwaters of the Verde River and affect availability of surface water as a supply. The relative contribution of the proposed pumping to Verde River flow is the matter of considerable debate (see Groundwater section below).

The location of surface water resources are shown on surface water condition maps and maps showing perennial and intermittent streams and major springs for each basin, and in basin tables that contain data on streamflow, flood ALERT equipment, reservoirs, stockponds and springs in the Water Resource Characteristics sections for each basin.

Groundwater

Compared to the deep alluvial basins found in the southern part of Arizona, high elevations, steep topography and extensive areas of bedrock in the Central Highlands Planning Area translate into relatively minimal groundwater storage capabilities and high runoff. These conditions result in limited, drought-sensitive water supplies for some communities, such as Pine, Strawberry, Payson, Black Canyon City and Mayer. Areas of unconsolidated sediments are relatively limited as shown on the groundwater conditions maps for each basin in sections 5.1-5.5. Many basin fill aquifers in the planning area are narrow and surrounded by low water yielding consolidated rocks. Areas of relatively high water yield include basin fill deposits in the Big Chino Sub-basin, Verde Valley Sub-basin, north of Globe in the Salt River Lakes Sub-basin, and near Wickenburg in the Upper Hassayampa Basin.

In much of the northern half of the Agua Fria Basin, parts of the Salt River Basin including the entire eastern portion, and the Verde Canyon Sub-basin, groundwater occurs in volcanic rocks that yield relatively small volumes of water. These conditions pose groundwater supply challenges for Payson and other communities in the planning area. In Pine, Strawberry and near Globe, groundwater is found in relatively low yield sedimentary rocks. Sedimentary rocks with moderate yields are found in the southern half of the Agua Fria Basin, while Precambrian schist near Black Canyon City yields relatively small volumes of water to wells.

Although groundwater supplies may be limited in some areas, it is the primary water supply in the planning area. Groundwater pumpage averaged about 46,700 acre-feet a year during the period 2001 to 2003.

In order to better understand the water supply situation in areas of the state where data are lacking, the Department has established automated groundwater monitoring sites that record water levels in wells. This information is available through an interactive map on the Department's website to allow access to local information for planning, drought mitigation and other purposes. (www.azwater.gov/dwr/). These devices were located based on areas of growth, subsidence, type of land use, proximity to river/stream channels, proximity to water contamination sites or areas affected by drought.

Figure 1-18 of Volume 1 of the Atlas shows the location of automatic water-level recording sites as of 2005. At that time there were 13 sites in the planning area, ten of which were USGS sites. There are currently five automated Department-operated sites in the planning area (three in the Verde River Basin, one in the Agua Fria Basin and one in the Upper Hassayampa Basin) for which current water level data are available. Index well hydrographs, which display historic water level behavior in more than 150 index wells in the planning area (particularly in the Verde River Basin) are also available at the same web location through an interactive map. Information on major aquifers, well yields, estimated natural recharge, estimated water in storage, aquifer flow direction, and water level changes are found in groundwater data tables, groundwater conditions maps, hydrographs and well yield maps for each basin in the Water Resource Characteristics sections.

Transportation of groundwater between groundwater basins is prohibited in Arizona unless allowed in statute. In 1991, the Arizona statutes recognized a volume of groundwater that can be transported into the Prescott AMA from the Big Chino Sub-basin. Under A.R.S. 45-555(E), the City of Prescott can withdraw an amount not to exceed 14,000 acre-feet per year. The Director of ADWR has issued an advisory opinion that the amount that may be withdrawn by the City of Prescott is 8,717 acre-feet[5]. Additionally, the statute allows for cities and towns to withdraw groundwater associated with historically irrigated acres (HIA) for transportation into the Prescott AMA. The Department has currently identified 3,307.58 acres of HIA in the Big Chino Sub-basin[6]. The Department will make a determination regarding the volume of water that can be transported from HIA lands after a request is submitted. In general, the allotment associated with HIA is 3 acre-feet per acre per year (ADWR, 2006).

An important issue facing the Central Highlands Planning Area is the potential for additional groundwater withdrawals from the Big Chino Sub-basin to reduce flows in the headwaters area of the Verde River, and environmental impacts associated with reduced flows and impacts associated with construction of pipelines and other infrastructure to transport groundwater. Although a number of studies have been conducted to investigate the connection of Big Chino Sub-basin groundwater with the headwaters of the Verde River, the relative contribution of the various potential sources is still a matter of speculation (McGavock, 2003).

Effluent

Effluent is a water supply for golf course irrigation in the Tonto Creek Basin and the Verde River Basin, totaling 1,030 acre-feet within the planning area. The Town of Clarkdale wastewater treatment plant discharges effluent onto mine tailings for dust control (USBOR, 2003). Effluent used in the Tonto Creek Basin is actually generated in the Verde River Basin. The volume of effluent generated by every facility in the planning area was not available to the Department, as shown on the effluent generation tables in each basin section. From data that were available it appears that limited volumes of effluent are produced in the Agua Fria and Tonto Creek basins. Approximately 2,600 acre-feet are generated in the Salt River Basin, primarily on the White Mountain Apache reservation and at Globe and Miami. In the Upper Hassayampa Basin, the Wickenburg wastewater treatment plant generates about 560 acre-feet of effluent a year. About 6,650 acre-feet of effluent is generated annually in the Verde River Basin, primarily at facilities located in Cottonwood, Munds Park, Payson and Sedona. In total, about 9,900 acre-feet of effluent are generated annually within the planning area.

Contamination Sites

Sites of environmental contamination may impact the use of some water supplies. An inventory of Department of Defense (DOD), Resource Conservation and Recovery Act (RCRA), Superfund (Environmental Protection Agency designated sites), Water Quality Assurance Revolving Fund (WQARF, state designated sites), Voluntary Remediation Program (VRP) and Leaking

[5] This volume is not a final determination and may be adjusted.
[6] See the Department's report "Identification of Historically Irrigated Acres in the Big Chino Sub-basin and Discussion Regarding Transportation of Groundwater into the Prescott AMA"

Underground Storage Tank (LUST) sites was conducted for the planning area. Of these various contaminated sites, DOD, LUST, RCRA, VRP and WQARF sites are found in the planning area. Table 5.0-8 lists the contaminant and affected media and the basin location of each site except LUST sites. The location of all contamination sites is shown on Figure 5.0-13.

There is one DOD site, Camp Navajo, located near Bellemont in the Verde River Basin. This site was used for over 50 years for land disposal of excess, obsolete and unserviceable munitions where they were destroyed by burning or by detonation. The site is being cleaned up according to RCRA standards under the DOD's Installation Restoration Program. There is also a RCRA site at Bellemont. The RCRA program regulates the management of hazardous waste handlers which includes generators, transporters and facilities for treatment, storage and disposal (ADEQ, 2002).

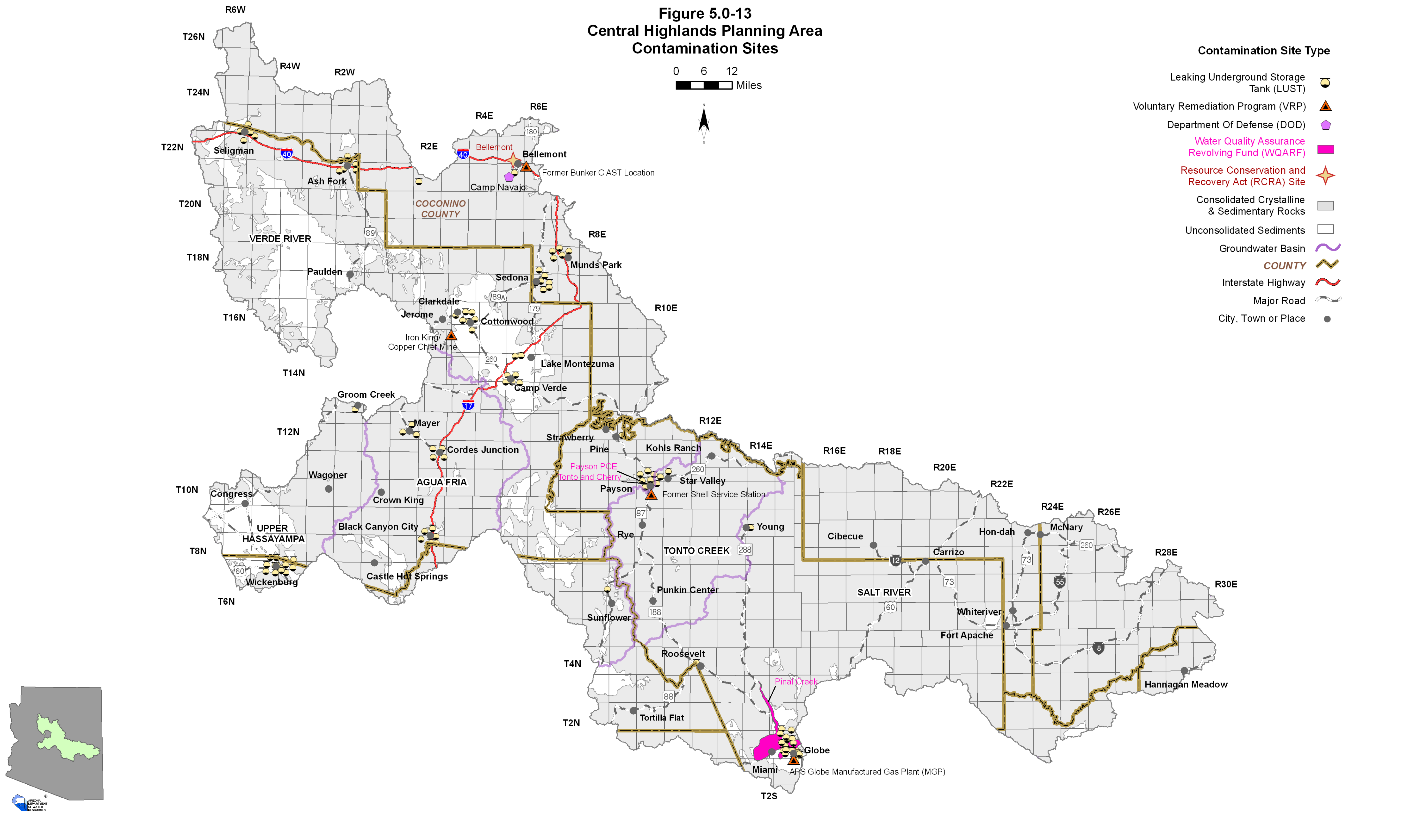
The Pinal Creek WQARF Site, located in the vicinity of Miami-Globe, is contaminated from mining and mineral processing in the area that began in 1878. Groundwater contamination was first observed in the 1930s in the alluvial aquifer of Miami Wash. By the time the first area-wide investigation of groundwater and surface water was conducted in 1979-81, there was widespread contamination. As of April 2006, approximately 105 million pounds of heavy metals had been removed from area aquifers. Site-wide monitoring is on-going including monthly sampling of 80-100 wells, four surface water sites and treated effluent at the Lower Pinal Creek treatment plant (ADEQ, 2006c).

Table 5.0-8 Active contamination sites in the Central Highlands Planning Area

SITE NAME	MEDIA AFFECTED AND CONTAMINANT	GROUNDWATER BASIN
Department of Defense Sites/Resource Recovery and Conservation Act (RCRA) Sites		
Camp Navajo, Bellemont	Soil, Groundwater - Metals, Volatile Organic Compounds, Solvents, White Phosphorous, Unexploded Ordnance	Verde River
WQARF Sites		
Payson PCE	Groundwater - Tetrachloroethene (PCE)	Verde River
Tonto/Cherry	Groundwater - Tetrachloroethene (PCE) and Methyl Tertiary Butyl Ether (MTBE)	Verde River
Pinal Creek	Groundwater, Surface Water - Metals, Radiochemicals, TDS, Acidity	Salt River
Voluntary Remediation Sites		
APS Globe Manufactured Gas Plant	Soil, Groundwater - Hydrocarbons, Cyanide, Arsenic, Lead	Salt River
Former Bunker C AST Location	Soil - Total petroleum hydrocarbons, Polycyclic aromatic hydrocarbons	Verde River
Former Shell Service Station	Soil, Groundwater - Total petroleum hydrocarbons, Polycyclic aromatic hydrocarbons, Ethyl Benzene, Total Xylene, Metals	Verde River
Iron King Copper Chief Mine	Surface Water - Metals	Verde River

Sources: ADEQ 2002, ADEQ 2006a, ADEQ 2006b

Figure 5.0-13
Central Highlands Planning Area
Contamination Sites



There are also two WQARF sites in the Payson area. At the Payson PCE site, groundwater is contaminated with tetrachloroethene (PCE). Two groundwater treatment systems capture and treat the contaminated water, which following treatment is delivered to the town as drinking water. The treated water comprises about a sixth of the town's total drinking water supply. PCE also contaminates groundwater at the Tonto and Cherry site but cleanup procedures will not commence until a Remedial Investigation Report is completed. A number of assessments and response actions have been conducted at this site including well monitoring and soil gas surveys (ADEQ, 2007).

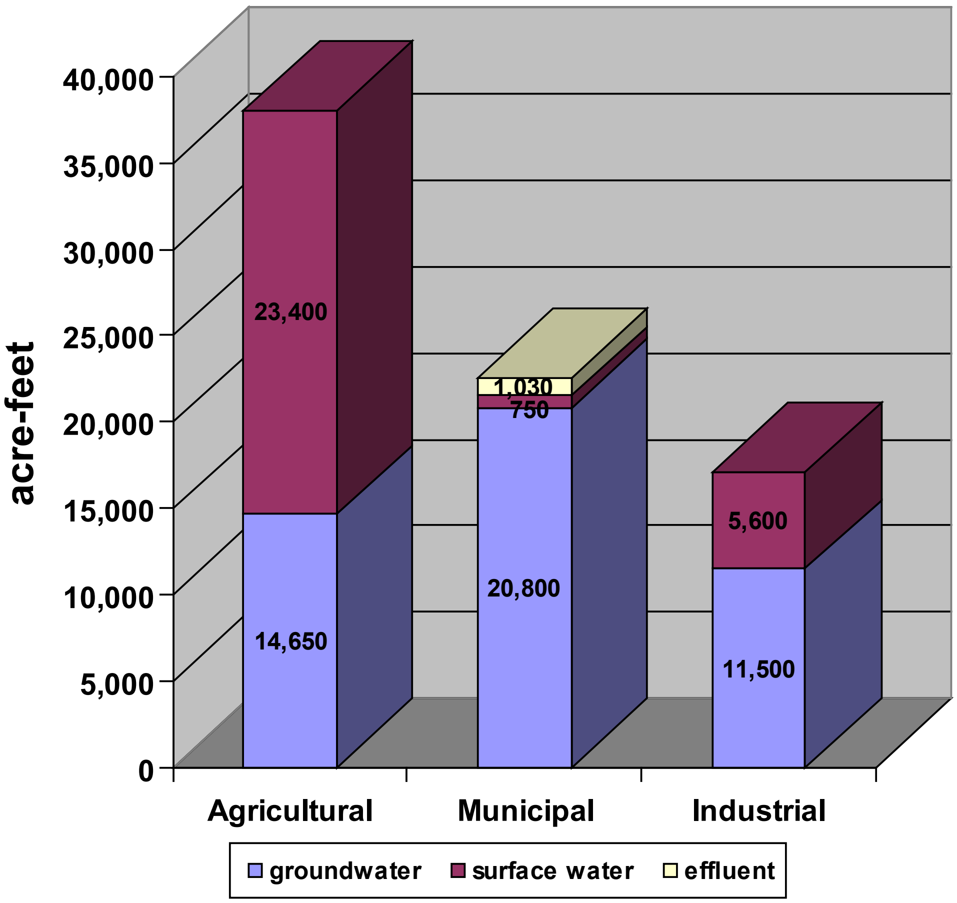
Four active VRP sites are located in the planning area with hydrocarbon and metal contamination of soil, groundwater and surface water. The VRP is a state administered and funded voluntary cleanup program. Any site that has soil and/or groundwater contamination, provided that the site is not subject to an enforcement action by another program, is eligible to participate. To encourage participation, ADEQ provides an expedited process and a single point of contact for projects that involve more than one regulatory program (Environmental Law Institute, 2002).

There are 143 active LUST sites in the planning area. Thirty one sites are located near Globe in the Salt River Basin, 22 sites are located in and around Wickenburg in the Upper Hassayampa Basin, 21 sites occur in the vicinity of Payson and Star Valley in the Verde River and Tonto Creek basins, and there are ten sites near Clarkdale and Cottonwood in the Verde River Basin. Ash Fork, Black Canyon City, Camp Verde, Munds Park, Sedona and Seligman each contain between 5 and 10 sites.

5.0.7 Cultural Water Demand

Total cultural water demand in the Central Highlands Planning Area averaged approximately 77,650 acre-feet per year during the period from 2001-2003. In 2003, total demand was about 79,100 acre-feet. As shown in Figure 5.0-14, the agricultural demand sector is the largest use sector with approximately 38,000 acre-feet of demand, 49% of the total. Most agricultural demand is located in the Verde River and Salt River basins. About 61% of the agricultural demand is met by surface water diverted primarily from the Verde and Salt Rivers and from Tonto Creek. Municipal demand represents about 29% of the total planning area demand with an average of 22,580 acre-feet during the period 2001-2003. Municipal demand is primarily met by groundwater and the municipal sector is apparently the only sector that utilizes effluent. Industrial demand, mainly related to mining, accounted for 17,070 acre-feet, 22% of the total demand during this period. However, almost all the surface water diverted for industrial purposes, about 5,500 acre-feet on average during 2001-2003, was transported out of the planning area for use at the Morenci Mine in the Southeastern Arizona Planning Area.

Figure 5.0-14 Central Highlands Planning Area average cultural water demand by sector, 2001-2003 in acre-feet



Note: effluent demand is from 2006

Several recent studies provide detailed information on irrigation and other water uses in the Verde River Basin. The Verde River Watershed Study Report (ADWR, 2000) contains information on water demand for most of the Basin. The Yavapai County Water Advisory Committee (WAC) completed a water use study of the Big Chino Sub-basin in 2004 and participated in a USBOR study of the Verde Valley in 2003 that are valuable sources of information.

Tribal Water Demand

The largest Indian reservation in the planning area is the Fort Apache, the fourth largest reservation in terms of size in Arizona. The northern part of the San Carlos Apache Indian Reservation is also within the planning area and directly south of the Fort Apache Indian Reservation, however almost all its population and water demand is in the Southeastern Arizona Planning Area (see discussion in Arizona Water Atlas Volume 3, Section 3.0.7).

Water demand on the Fort Apache Indian Reservation is associated with domestic and agricultural uses as well as a number of tribal enterprises including timber industries, a ski resort, and a casino/ hotel at Hon-dah. There are approximately 12,000 tribal members residing on the reservation with about 2,500 residents at Whiteriver, the tribal capital. Other residents reside in smaller communities and on rural lands. Water service is provided to an unknown number of customers by the Whiteriver Regional System. Water demand on the San Carlos Apache Reservation portion within the planning area is assumed to be primarily due to agricultural irrigation of orchard crops (ADWR, 1992). Using agricultural and industrial demand estimates in the Hydrographic Survey Report for the Upper Salt River Watershed, and per capita assumptions derived from a 2005 study by Truini et al. on other reservations, it is estimated that the annual demand of the two largest tribes in the planning area is about 4,500 acre-feet (Table 5.0-9).

Table 5.0-9 Estimated Water Demand on the Fort Apache and San Carlos Apache Indian Reservations

	Agricultural (surface water)	Municipal (groundwater/ surface water)
Fort Apache	3,690	700/60[1]
San Carlos Apache	70	0
Total	3,760	700/60

[1] Assumes 94 gpcd at Whiteriver and 40 gpcd elsewhere. Commercial demand outside of Whiteriver not included. Sixty acre-feet of surface water is used at Cedar Creek
Sources: ADWR, 1992; Truini et al., 2005

The Tonto Apache and Yavapai-Apache Indian Reservations and tribal populations are relatively small and demand estimates were not available to the Department. The Tonto Apache Indian Reservation is the smallest land base reservation in Arizona at 85 acres. Principal water demands are associated with the Mazatzal Casino and restaurant, and tribal offices. Water service is provided by the Tonto Apache Water System. The 656-acre Yavapai-Apache Indian Reservation is located on five separate parcels with its tribal headquarters at Middle Verde. This parcel is served water by the Middle Verde Indian Water System while other parcels are served by private water companies that also serve adjacent, non-reservation lands. Tribal lands include irrigated farmland, residences and commercial businesses. The tribe operates the Cliff Castle Casino and motel north of Camp Verde (see Figure 5.5-2). (ITCA, 2003)

Municipal Demand

Municipal demand is summarized by groundwater basin and water supply in Table 5.0-10. Average annual demand from 2001 to 2003 was 22,580 acre-feet. Ninety-two percent of the municipal demand is met by groundwater. A small amount of surface water is used in the Salt River Basin at facilities located at the Salt River lakes and on the Fort Apache Indian Reservation at Cedar

Creek, a small community located southeast of Carrizo. In the Verde River Basin surface water is used at several locations including by Beaver Valley Water Company, Bonita Water Company (Payson), Camp Navajo, Kohl's Ranch, Pine Water Association, Stoneman Lake Water Company and the Town of Jerome, which uses about 400 acre-feet per year from Big and Little Allen Springs (USBOR, 2003). Effluent is used for turf irrigation in the Verde River and Tonto Creek basins and for dust control on mine tailings by the Town of Clarkdale.

Table 5.0-10 Average annual municipal water demand in the Central Highlands Planning Area (2001-2003) in acre-feet

Basin	Groundwater	Surface Water	Effluent[1]	Total
Agua Fria	1,800			1,800
Salt River	4,000	<300[2]		<4150
Tonto Creek	2,200		200	2,400
Upper Hassayampa	2,800			2,800
Verde River	10,000	600	830	11,430
Total Municipal	20,800	750	1,030	22,580

Sources: USGS 2005d, ADWR 2005b
[1] Effluent figures are for golf course and other turf irrigation in 2006
[2] Assume 150 acre-feet for computation purposes

Primary municipal demand centers are located around Cottonwood, Globe-Miami, Payson, Sedona, and Wickenburg. Municipal demand in the Verde River Basin accounts for 51% of the total municipal demand in the planning area. There is relatively little municipal water demand in the Agua Fria Basin. It is estimated that about eleven percent of the planning area population is not served by a municipal water provider.

Eight water providers in the planning area served 450 acre-feet of water or more in 2003. These providers and their demand in 1991, 2000 and 2003 are shown in Table 5.0-11. In 2003, municipal utilities served Globe, Payson and Wickenburg. Beginning in 2005, the City of Cottonwood began acquisition of the four private water companies serving the town; Clemenceau Water Company, Cordes Lakes Water Company, Cottonwood Water Works and the Verde Santa Fe Water Company. Municipally-owned systems have more flexible water rate-setting ability than private water companies, which are regulated by the Arizona Corporation Commission. In addition, municipal utilities have the authority to enact water conservation ordinances. These authorities may enable municipal utilities to better manage water resources within water service areas. Water provider issues are discussed in section 5.0.8.

The towns of Miami-Claypool are served by Arizona Water Company. About 87% of the approximately 3,250 connections are residential. The system also serves water for turf irrigation. The Miami water system is served by 17 wells and has a two-way emergency interconnection with the City of Globe. Water levels in wells ranged from 109 feet to 860 feet below land surface in 2006. (Arizona Water Company, 2007a)

The City of Globe has an adequate water supply designation and serves about 7,700 customers from five active wells. Four of these wells are located in the Safford Basin in the Southeastern Arizona Planning Area. About two-thirds of the water demand is residential and one-third is non-residential. The City has a water conservation plan that it credits with helping to keep water demand in check. Water levels in wells ranged from 40 feet to 650 feet below land surface in 2005. (City of Globe, 2005) The Wickenburg municipal water system serves groundwater to about 5,100 residents.

Table 5.0-11 Water providers serving 450 acre-feet or more of water per year in 2003, excluding effluent, in the Central Highlands Planning Area

Basin/Water Provider	1991 (acre-feet)	2000 (acre-feet)	2003 (acre-feet)
Salt River			
Arizona Water Company-Miami	1,031	1,194	1,068
City of Globe	1,446	1,558	1,550
Upper Hassayampa			
Town of Wickenburg	1,249	1,717	1,774
Verde River			
Arizona Water Company - Sedona	1,764	2,816	3,375
Big Park Water Company - Village of Oak Creek	539	799	873
Cottonwood Water Works - Cottonwood & Clarkdale	1,321	2,065	2,050
Cordes Lakes Water Company - Cottonwood	590	1128	1,385
Town of Payson	1,089	1,550	1,683

Sources: ADWR 2007 and 2004
Notes: Cordes Lakes Water Company also serves the community of Cordes Lakes; the amount shown here is for City of Cottonwood alone. City of Cottonwood purchased Cordes Lakes Water Company and Cottonwood Water Works after 2003.

Arizona Water Company serves the town of Sedona. It has 14 active wells, and about 5,500 connections, 78% of which are residential. Sedona has a high percentage of seasonal residents, and daily visitors contribute to a relatively high gallons per capita per day (gpcd) rate of 244 (USBOR, 2003). The system serves commercial customers and turf facilities. The service area includes central Sedona from Red Rock Loop Road to east of downtown. The Valley Vista “sub-system” serves an area south of Verde Valley School Road, mostly west of Highway 179. Arizona Water Company maintains an emergency two-way interconnection with the Oak Creek Water Company. Groundwater depth is about 220 feet in utility wells. (Arizona Water Company, 2007b)

Big Park Water Company serves the Village of Oak Creek, an unincorporated community south of Sedona along Highway 179. It has about 2,800 connections, of which 91% are residential, and a per capita rate of about 198 gpcd (USBOR, 2003). It does not serve turf facilities. Depth to water in the seven system wells is about 390 feet and water levels are reportedly stable. Big Park Water Company has an interconnection with Little Park Water Company. (BPWC and LPWC, 2007) Both companies have designations of Adequate Water Supply.

Prior to 2005, Cottonwood Water Works and Cordes Lakes Water Company were the two large private water companies serving the City of Cottonwood. The Old Cottonwood Water Works system served the communities of Cottonwood and Clarkdale and consisted of about 4,600 connections of which 97% were residential. The combined Cordes Lakes Water Company Systems serve a population of almost 7,700 consisting of six separate systems in the Verde Village area. (A separate Cordes Lakes Water Company System serves the community of Cordes Lakes in the Agua Fria Basin). The estimated gpcd rate of Cottonwood is about 148 gpcd and Clarkdale is about 193 gpcd (USBOR, 2003).

The four systems that are now owned by the City of Cottonwood (Clemenceau, Cordes Lakes, Cottonwood Water Works and Verde Santa Fe) pumped a total of about 3,150 acre-feet of water in 2006. The City of Cottonwood currently operates the Clarkdale system (formerly part of Cottonwood Water Works), which served about 3,000 people and pumped about 400 acre-feet in 2006. (Cottonwood Water Works, 2007)

The Town of Payson pumps groundwater from the surrounding granite aquifer from 32 active wells to about 14,000 residents. Most wells are located in the Verde River Basin and some are in the Tonto Creek Basin. The town estimates that there are also about 300 to 400 domestic wells operating within its service area. It also supplies water to the Tonto Apache Indian Reservation. Because of the aquifer's limited storage capacity, Payson is a drought-sensitive area dependent on sufficient rainfall and snowmelt for an adequate drinking water supply (City of Payson, 2007). Payson monitors water levels in its wells regularly to gauge water supply availability and has aggressive water conservation, effluent reuse and drought programs. Water levels in wells trigger the town's drought response. Payson's water demand declined by 7% between 2002 and 2003, which it attributes to conservation efforts including implementation of a water conservation ordinance, March 2003. (Maguire, 2005)

About 80% of Payson's population is connected to the Northern Gila County Sanitary District sewer system that provides wastewater treatment for Payson and much of the surrounding area. Current system inflows are about 800,000 gallons daily, or 50% of capacity. The District's effluent is used for a variety of irrigation projects and ground water recharge, including the Green Valley Lake project. The 48-acre Green Valley Park was developed jointly by the Town of Payson Water Department and the Sanitary District. Treated effluent from the district's water treatment plant fills a 10.5-acre lake used for boating and fishing and adjacent irrigated areas and recreational facilities. (Payson Regional Economic Development Corporation, 2006) Another effluent recharge project, Rumsey Park, is in the pilot phase.

Municipal water providers served about 1,400 acre-feet of groundwater to golf courses in 2006. Most golf courses are located in the Verde River Basin. Golf courses with their own facility wells, considered "industrial users", used about 2,200 acre-feet of groundwater and about 800 acre-feet of surface water in 2006. Most golf courses in the planning area are industrial facilities and their demand is included in the industrial category. A number of the industrial facilities also receive "municipal" effluent. Effluent is delivered to the Payson-area courses of Chaparral Pines, Rim and Payson. Pinewood Golf Course at Munds Park, Talking Rock, near Prescott and Verde Santa Fe at Cornville also use effluent for irrigation although no courses use 100% effluent. About 1,050 acre-feet of effluent, 19% of total golf course demand, is used for golf course irrigation. In total, golf course demand is about 5,400 acre-feet, about 7% of the total planning area demand. Golf course demand by municipal and industrial facilities, basin location and source of water is shown in Table 5.0-12.

Table 5.0-12 Golf course demand in the Central Highlands Planning Area (c.2006)

Facility	Basin	# of Holes	Demand (acre-feet)	Water Supply
Cobre Valley Country Club - Globe*	Salt River	9	211	Groundwater
Chaparral Pines Golf Course - Payson	Tonto Basin	18	108/107	Groundwater/Effluent
Rim Golf Course - Payson	Tonto Basin	18	108/108	Groundwater/Effluent
Los Caballeros Golf Club - Wickenburg	Upper Hassayampa	18	423	Groundwater
Wickenburg Country Club	Upper Hassayampa	9	211	Groundwater
Beaver Creek Country Club - Lake Montezuma*	Verde River	18	490	Surface Water
Canyon Mesa Golf Course - Sedona*	Verde River	9	113	Groundwater
Oak Creek Country Club - Village of Oak Creek*	Verde River	18	701	Groundwater
Payson Golf Course - Payson	Verde River	18	132/309	Groundwater/Effluent
Pine Shadows - Cottonwood*	Verde River	9	98	Groundwater
Pinewood Country Club - Munds Park*	Verde River	18	270/269	Surface Water/Effluent
Poco Diablo Golf Course - Sedona*	Verde River	9	34	Surface Water
Sedona Golf Resort - Sedona*	Verde River	18	456	Groundwater
Seven Canyons Four Seasons Golf Course - Sedona	Verde River	18	423	Groundwater
Talking Rock - Northwest of Prescott*	Verde River	18	200/200	Groundwater/Effluent
Verde Santa Fe - Cottonwood*	Verde River	18	401/55	Groundwater/Effluent

Source: ADWR 2000, ADWR 2005b
Notes:
* These golf courses are served by their own wells and considered to be industrial users

Agricultural Demand

Agricultural demand in the planning area is about 38,000 acre-feet a year, or 49% of the total cultural demand. Most irrigation is for pasture. As shown in Table 5.0-13, there is agricultural demand in all basins but most (72%) is located in the Verde River Basin.

An estimated 6,400 acres are in agricultural production in the Verde River Basin, primarily in the Big Chino and Verde Valley sub-basins. The predominant crop grown is pasture, which is typically deficit irrigated. Groundwater is the primary supply in the Big Chino Sub-basin while surface water is predominantly utilized in the Verde Valley Sub-basin. Detailed maps showing current and historic irrigation in the Big Chino and Verde Valley sub-basins and much of the Verde Canyon Sub-basin are found in the Verde River Watershed Study Report (ADWR, 2000). This study also includes a description of each of the irrigation associations including information on acreage, water supply and facilities. In addition, maps of irrigated lands are also found in the WAC/USBOR Reports.

Most current irrigation in the Big Chino Sub-basin is located along Big Chino Wash about 15 miles northwest of Paulden, along Williamson Valley Wash and near Paulden. A smaller number of acres are irrigated in the Walnut Creek area near the western sub-basin boundary. Irrigation methods are predominantly flood or sprinkler irrigation. Pasture is the most prevalent crop as well as alfalfa, small grains and corn. (Yavapai County Water Advisory Committee, 2004)

Table 5.0-13 Agricultural Demand in the Central Highlands Planning Area

	1991-1995 (acre-feet)	1996-2000 (acre-feet)	2001-2003 (acre-feet)
Agua Fria			
Groundwater	1,300	1,300	1,600
Total	1,300	1,300	1,600
Salt River			
Groundwater	<1,000	<1,000	<1,000
Surface Water	6,400	6,400	6,400
Total	6,900	6,900	6,900
Tonto Creek			
Groundwater	<1,000	<1,000	<1,000
Surface Water	1,000	1,000	1,000
Total	1,500	1,500	1,500
Upper Hassayampa			
Groundwater	<1,000	<1,000	<1,000
Total	<1,000	<1,000	<1,000
Verde River			
Groundwater	8,100	8,400	11,500
Surface Water	11,500	12,500	16,000
Total	19,600	20,900	27,500

Source: USGS 2005d, ADWR 2005d
Notes: Volumes <1,000 acre-feet assumed to be 500 acre-feet for computational purposes

About 30 irrigation associations divert surface water in the Verde Valley Sub-basin. Most of the irrigated lands in the sub-basin are located along the Verde River or its major tributaries. During drought, approximately 1,200 irrigation wells in the Verde Valley may be used to meet irrigation demands. Agricultural lands are located primarily along the Verde River north and south of Camp Verde, where a number of ditch companies serve water to about 2,800 acres. Irrigated lands are also located near the communities of Cornville and Page Springs. Pasture is grown on about two-thirds of the irrigated land. Other crops include alfalfa, corn, wheat, vegetables and orchards. (ADWR, 2000)

Small areas of irrigated acreage are located in the Agua Fria Basin north of Cordes Junction and in the Upper Hassayampa Basin north of Wagoner (see Figures 5.1-10 and 5.4-10). In the Tonto Creek Basin the Gisela Community Ditch Association delivers surface water diverted from Tonto Creek through a 3-mile long ditch to about 144 acres near the community of Gisela, east of Rye (see Figure 5.3-10). Reportedly, much more water is diverted than used due to system configuration but the excess is assumed to return to the creek. Agricultural lands consist of pasture and orchard. Some acreage may be supplemented with groundwater. (ADWR, 1992) A relatively small amount of groundwater-supplied irrigation occurs in the lower reaches of Tonto Creek. The

USGS estimates that about 270 acres are being actively farmed in the Tonto Creek Basin (USGS 2005d).

Annual agricultural demand in the Salt River Basin is about 6,900 acre-feet primarily associated with pasture irrigation for livestock raising operations. Most of the irrigated areas are in Pleasant Valley near Young and near the community of Fort Apache. An estimated 3,200 acre-feet of demand is located on non-reservation lands with about 650 acres in production. Approximately 2,700 acre-feet of surface water and 500 acre-feet of groundwater are used. Historically, small tracts of irrigated land were located throughout the basin including along the Salt River upstream of Roosevelt Lake, north of Globe and in the White Mountains. Recent field investigations have not been conducted in this basin and the USGS National Gap Analysis Program did not identify irrigated acreage in these areas (see Figure 5.2-10). Agricultural demand on the Fort Apache Indian Reservation is estimated to be about 3,600 acre-feet of surface water with 1,050 acres in production. Only about 20 acres are irrigated with surface water on the portion of the San Carlos Apache Indian Reservation located in the planning area, with an associated demand of about 70 acre-feet. (ADWR, 1992)

Although agricultural demand estimates are uncertain in parts of the planning area due to a lack of reporting and recent field studies, it does appear that agricultural demand has declined in the Verde River Basin compared with demand prior to 1990. Agricultural demand may continue to decline in part due to groundwater transportation activities. In 2004, the City of Prescott, in partnership with the Town of Prescott Valley, purchased the JWK Ranch in the Big Chino Sub-basin for the anticipated purpose of retiring agricultural use and pumping groundwater to the Prescott Active Management Area pursuant to A.R.S.§ 45-555. The final determination of the allowable pumpage and transportation volume has not been made.

Industrial Demand

Industrial demand in the planning area averaged about 17,100 acre feet annually during the period 2001-2003. As shown in Table 5.0-14, industrial demand in the planning area consists of mining, golf course irrigation served by facility water systems and a dairy. These same use categories that are served by a municipal water system are accounted for as municipal demand. There is likely additional industrial demand in the planning area not reflected in Table 5.0-14.

Most of the industrial demand is due to mining-related operations in the Salt River Basin and to surface water exported from the Black River to the Morenci Mine in the Southeastern Arizona Planning Area. Mining demand increased from 2000 to 2003 due to an increase in surface water exports to the Morenci Mine. In 2003, groundwater use was approximately 6,400 acre-feet at the Phelps Dodge Miami Copper Mine, 350 acre-feet at the BHP Pinto Valley Copper Mine and 50 acre-feet at sand and gravel facilities. In 2003, about 100 acre-feet of surface water was used at the Miami mine and about 6,500 acre-feet was transported to the Morenci mine. In 1991 and 2000 all the surface water use was at the Morenci mine.

Mining operations have ceased at the Miami Mine where current activity involves smelter operations, an electrorefinery, and a copper rod mill that produces continuous-cast copper rod used as the feedstock for the wire and cable industry (Arizona Mining Association, 2006). With rising copper prices, Phelps Dodge is continuing to evaluate reopening the Miami Mine.

Table 5.0-14 Industrial demand in selected years in the Central Highlands Planning Area

	1991	2000	2003
Type	**Water Use (acre-feet)**		
Mining Total	**16,200**	**12,900**	**14,900**
Salt River			
Groundwater	10,000	8,000	7,000
Surface Water[2]	5,000	3,700	6,600
Verde River			
Groundwater	1,200	1,200	1,300
Golf Course Total	**2,400**	**2,600**	**2,800**
Salt River			
Groundwater	200	200	200
Verde River[1]			
Groundwater	1,400	1,600	1,800
Surface Water	800	800	800
Dairy/Feedlot Total	**800**	**800**	**800**
Upper Hassayampa			
Groundwater	800	800	800

Source: ADEQ 2005, ADMMR 2005, ADWR 2000, ADWR 2005b, USGS 2005d

[1] Three golf courses also receive effluent, see Table 5.0.9 for more information.

[2] Most of the surface water diverted for mining in the Salt River Basin is water transported to the Southeastern Arizona Planning Area for use at the Morenci Mine.

Full copper mining operations are expected to resume at the Pinto Valley mine in 2007. Also, there are plans to open the Carlota Copper Mine about six miles west of Miami in 2008. This project will involve open pit mining and a heap leach operation with a nine year mine life. Up to 75 million pounds per year of copper may be produced (Quadra Mining LTD., 2005).

Mining activity has declined from historic levels but it continues to be an important industry in the planning area as it has been for many years. Historically significant mines include the Vulture Gold Mine near Wickenburg that was in production sporadically for about a hundred years beginning in 1864, and the United Verde Mine at Jerome/Clarkdale, which operated from 1876 to 1953. The United Verde Mine was at one time the largest copper mine in Arizona, producing 3 million pounds of copper per month. A number of smaller mining operations were located around Crown King and north of Castle Hot Springs in the Agua Fria Basin. While some existing mines have been out of production in recent years, mining may resume at some sites (e.g. Miami) if determined to be economically feasible.

In addition to metal mining, sand and gravel and cement operations are included in the mining category. In 2003 about 1,300 acre-feet of groundwater was used in the Verde River Basin by several sand and gravel operations and Phoenix Cement, a manufacturer of Portland Cement located near Clarkdale. A cement plant has been proposed near Drake, northwest of Paulden, that could use about 80 acre-feet of water per year (Wirt, 2005).

Ten of the sixteen known golf courses in the planning area are "industrial" courses located primarily in the Verde River Basin. Industrial courses receive at least some water from facility wells and not from a municipal water provider. Industrial groundwater demand is about 2,800 acre-feet a year and three of the courses also use a total of about 524 acre-feet of municipal effluent a year. (See Table 5.0-12).

The Parker Dairy, located east of Congress in the Upper Hassayampa Basin, commenced operation in 1987. It houses over 7,000 dairy cows with an estimated annual groundwater demand of about 800 acre-feet.

5.0.8 Water Resource Issues in the Central Highlands Planning Area

A number of complex water resource issues exist in the Central Highlands Planning Area. Issues have been identified in water resource studies, by community watershed groups, through the distribution of surveys, and from other sources. Issues and planning, conservation and research activities are discussed in this section.

Planning and Conservation

Many communities in the planning area are facing rapid population growth in a region of the state where physical and legal access to water supplies creates significant challenges. These challenges have resulted in the formation of several community watershed groups, water resource studies and planning, and drought response and water conservation efforts. Yavapai County is a major governmental entity in the planning area with the largest county land base. Because the County had a population of over 125,000 in the 2000 Census, it is required to include a water resource element in its General Plan. Its plan recognizes the need for public education and sees the county's role as a facilitator of sound water resource management practices. The Yavapai County Board of Supervisors, along with cities, towns, tribes and the Department of Water Resources created the Yavapai County Water Advisory Committee (WAC) to provide a water management strategy for Yavapai County. The goals of the county's general plan as they compare with the activities of the WAC are included in Yavapai County's General Plan.

By acquiring private water companies serving the town, Cottonwood is seeking more water resource management authority. The town is a participant in the WAC as are a number of communities in the Verde River Basin including Sedona, Clarkdale and Camp Verde.

The Town of Payson is the largest community in the planning area. Because its water system is drought sensitive and the community faces rapid population growth, the Town has undertaken a variety of water resource management activities. It has adopted ordinances that place conservation and no-impact requirements on new developments including prohibitions on swimming pools, turf and evaporative coolers in buildings over 3,000 square feet. It also imposes a water-development impact fee on new development. New residential subdivisions are limited to 20 lots and builders must provide their own sources of water without impacting Payson's water supplies (Maguire, 2005). Payson has a conservation water rate structure, a water conservation education program and a drought plan. Supply augmentation activities include using effluent for turf irrigation and groundwater recharge, and development of a program to transport 3,000 acre-feet of water from C.C. Cragin reservoir to Payson as provided for under the Arizona Water Rights Settlement Act.

Local Drought Impact Groups (LDIGs) are being formed in all counties across Arizona. LDIGs are voluntary groups that will coordinate drought public awareness, provide impact assessment information to local and state leaders, and implement and initiate local drought mitigation and response actions. These groups are coordinated by local representatives of Arizona Cooperative Extension and County Emergency Management and supported by ADWR's Statewide Drought Program.

To support the efforts of the LDIGs, professionals and residents are asked to provide monthly feedback on drought conditions throughout their county. Citizens may also participate with the LDIG by assisting with education and outreach efforts and recommending actions for drought mitigation and response. More information on LDIGs may be found at http://www.azwater.gov/dwr/drought/LDIG.html.

Watershed Groups and Studies

Several groups have formed in the planning area to address water resource issues. The most active groups in the planning area are the Citizens Water Advocacy Group, Citizens for Responsible Development, Northern Arizona Municipal Water Users Association, Upper Agua Fria Watershed Partnership, Verde River Basin Partnership, Verde Valley Water Users Association, Inc., Verde Watershed Association and the Yavapai County Water Advisory Committee. In 2005, Congress passed the Northern Arizona Land Exchange and Verde River Partnership Act, but to date this partnership has not formed. A description of those groups that are part of the Department's Rural Watershed Initiative Program, including participants, activities and issues, is found in Appendix B. Two of the groups listed in Appendix B encompass more than one planning area. Primary issues identified by these groups that pertain to the Central Highlands Planning area are summarized as follows:

Growth:
- Unregulated lot splits
- Proposed growth in Mayer, Bensch Ranch and Spring Valley
- 25,000 to 30,000 approved lots remain in Prescott AMA
- Thousands of private domestic wells and more pending
- Significant projected growth

Water Supplies and Demand:
- Limited and deep groundwater supplies
- Access to water development on public lands
- Limited groundwater data

- Limited supplies to meet projected demands
- Limited water resources to meet current demands
- Environmental, supply, treatment, transportation and financing costs associated with augmentation from C.C. Cragin reservoir
- Seasonal demand/peaking problems
- Potential impacts resulting from the transfer of Big Chino water to Prescott and Prescott Valley

Legal:

- Private water companies and domestic water improvement district conflicts
- Interbasin transfer conflicts resulting from Payson's ability to pump from two separate basins
- Unresolved Indian Water Rights settlements
- Subflow decision and impact on legal access to water
- Yavapai Ranch land exchange and Title II implementation
- Senior water right holders on the Verde River are landowners within the SRP boundaries

Water Quality:

- Water quality issues in Verde Valley
- Potential impacts from septic systems
- Ability to meet new Arsenic standard

Funding:

- Limited funding resources for planning, projects, infrastructure and studies
- High cost of water augmentation projects
- Costs associated with hauling water
- Infrastructure needs for private water companies

Drought:

- Drought sensitive groundwater and surface water supplies
- Drought sensitivity in Mayer, Spring Valley, Black Canyon City

Environmental:

- ESA issues involving groundwater usage impacts on perennial streams
- Environmental issues pertaining to Fossil Creek
- Verde River Wild and Scenic River status
- Proposed critical habitat area in Verde Valley for willow flycatcher
- Invasive species

Other:

- Poorly constructed and maintained infrastructure in some areas
- Political and philosophical differences between the Verde Valley and the Prescott AMA

A number of studies have been conducted in parts of the planning area, particularly in the Verde Basin. Many of these studies were undertaken as a result of initiatives by watershed groups and communities. Some of the noteworthy regional studies have been mentioned in previous sections and an extensive list of studies are included in the references and suggested reading sections found at the end of each basin section in this volume. Not included are studies under development. The USBOR is in the process of drafting a report of findings for the Mogollon Rim Water Resource Appraisal Study, which covers the Payson, Pine and Strawberry area. Recently, Northern Arizona University used USGS geophysical data to construct a 3-D geologic model that represents the subsurface geologic framework within the Big Chino Sub-basin and Prescott AMA. The model aids in understanding how groundwater flows within and between these areas. This work is being incorporated into a USGS numeric groundwater model being developed for the Verde Watershed and portions of the Coconino Plateau and Little Colorado River Watershed.

Issue Surveys

The Department conducted a rural water resources survey in 2003 to compile information for the public and help identify the needs of growing communities. This survey was also intended to gather information on drought impacts to incorporate into the Arizona Drought Preparedness Plan, adopted in 2004. Questionnaires were sent to almost 600 water providers, jurisdictions, counties and tribes. A report of the findings from the survey was completed in 2004 (ADWR, 2004).

There were 36 water provider and jurisdiction respondents in the Central Highlands Planning Area, but only 24 numerically ranked issues. Respondents were asked to rank 18 issues, which can be grouped into three categories: infrastructure, water supply and water quality. In the planning area, issues related to water quality and infrastructure were ranked among the top five issues by a majority of respondents; 66% in both categories. Water supply issues were considered key issues by 46% of the respondents. Table 5.0-15 shows the four specific issues that ranked highest in the planning area.

Table 5.0-15 Water resource issues ranked by 2003 survey respondents in the Central Highlands Planning Area (19 water providers and 5 jurisdictions)

Issue	Ranked as one of the top 5 issues (out of 18)	Percent of respondents
Lowering water tables near wells	6	25
Ability to meet new arsenic standards	8	33
Aging infrastructure in need of replacement	5	21
Inadequate captial for infrastructure improvement	8	33

Source: ADWR 2004

The Department conducted another, more concise survey of water providers in 2004. This was done to supplement the information gathered in the previous year in support of developing the Arizona Water Atlas, and to reach a wider audience by directly contacting each water provider. Through this effort, 74 water providers in the Central Highlands Planning Area, with a total of approximately 60,600 service connections, were willing to participate and provide information on water supply, demand, and infrastructure and to rank a list of seven issues.

In regard to the question of groundwater level trends in their service area, 59 respondents reported as follows: 25 stable, 21 falling, 9 did not know the condition of water levels in their service area, 3 reported variable water levels and 1 respondent in the Verde River Basin reported rising water levles. Responses are shown by basin with the number of respondents in Table 5.0-16.

Table 5.0-16 Groundwater level trends reported by 2004 survey respondents by groundwater basin (59 respondents)

Basin	Rising	Stable	Falling	Variable	Don't Know
Agua Fria		1	5		
Salt River		3			
Tonto Creek			1		2
Upper Hassayampa		6			
Verde River	1	15	15	3	7

Source: ADWR 2005c

As part of the 2004 survey, water providers were asked to rank 7 issues from 0 to 4 with 0 = no concern, 1 = minor concern, 2 = moderate concern and 3 = major concern. Of the 74 water providers that responded to the survey, 66 ranked issues. Water quality was not included as an issue in this survey. Although responses to the 2003 questionnaire are not directly comparable to the 2004 survey due to differences in the form and wording of the surveys, infrastructure issues ranked high, similar to the 2003 survey. In addition, concerns about drought related water supplies and supplies to meet future needs also rated high as shown in Table 5.0-17.

Table 5.0-17 Water resource issues ranked by 2004 survey respondents in the Central Highlands Planning Area (66 water providers)

Issue	Moderate concern	Major concern	Total	Percent of respondents reporting issue was a major or moderate concern
Inadequate storage capacity to meet peak demand	6	3	9	13
Inadequate well capacity to meet peak demand	5	7	12	18
Inadequate supplies to meet current demand	4	6	10	15
Inadequate supplies to meet future demand	4	17	21	32
Infrastructure in need of replacement	12	12	24	36
Inadequate capital to pay for infrastructure improvements	6	19	25	38
Drought related water supply problems	6	19	25	38

Source: ADWR 2005c

Table 5.0-18 shows how respondents to the 2004 survey within individual basins ranked issues. Inadequate capital for infrastructure improvements was a moderate or major concern for most respondents in all the basins while drought related water supply problems were identified as key issues for respondents in the Agua Fria and Verde River basins.

Table 5.0-18 Number of 2004 survey respondents, by groundwater basin, that ranked the survey water resource issues a moderate or major concern (66 water providers total)

Issue	Agua Fria (7)	Salt River (4)	Tonto Creek (5)	Upper Hassayampa (8)	Verde River (42)
Inadequate storage capacity to meet peak demand	1	2	1	2	7
Inadequate well capacity to meet peak demand	2		1		10
Inadequate supplies to meet current demand	1		1		12
Inadequate supplies to meet future demand	3	1	5	2	18
Infrastructure in need of replacement	3	2	3	3	16
Inadequate capital to pay for infrastructure improvements	4	2	4	3	21
Drought related water supply problems	5		4	2	25

Source: ADWR 2005c

5.0.9 Groundwater Basin Water Resource Characteristics

Sections 5.1 through 5.5 present data and maps on water resource characteristics of the groundwater basins in the Central Highlands Planning Area. A description of the data sources and methods used to derive this information is found in Section 1.3 of Volume 1 of the Atlas. This section briefly describes general information that applies to all of the basins and the purpose of the information. This information is organized in the order in which the characteristics are discussed in Sections 5.1 through 5.5.

<u>Geographic Features</u>
Geographic features maps are included to present a general orientation to principal land features, roads, counties and cities, towns and places in the groundwater basin.

<u>Land Ownership</u>
The distribution and type of land ownership in a basin has implications for land and water use. Large amounts of private land typically translate into opportunities for land development and associated water demand, whereas federal lands are typically maintained for a purpose with little associated water use. State owned land may be sold or traded, and is often leased for grazing and farming.

The extent of state owned lands is due to a number of legislative actions. The State Enabling Act of 1910 and the Act that established the Territory of Arizona in 1863 set aside sections 2, 16, 32 and 36 in each township to be held in trust by the state for educational purposes. Other legislation authorized additional state trust lands for specified purposes, which are identified for each basin (Arizona State Land Department, 2006).

Climate

Climate data including temperature, rainfall, evaporation rates and snow are critical components of water resource planning and management. Averages and variability, seasonality of precipitation and long term climate trends are all important factors in demand and supply planning.

Surface Water Conditions

Depending on physical and legal availability, surface water may be a potential supply in a basin. Stream gage, flood gage, reservoir, stockpond and runoff contour data provide information on physical availability of this supply. Seasonal flow information is relevant to seasonal supply availability. Annual flow volumes provide an indication of potential volumetric availability.

Criteria for including stream gage stations in the basin tables are that there is at least one year of record, and annual streamflow statistics are included only if there are at least three years of record. There are different types of stations and those that only serve repeater functions were not included.

Flood gage information is presented to direct the reader to sources of additional precipitation and flow information that can be used in water resource planning. Large reservoir storage information provides data on the amount of water stored in the basin, its uses, and ownership. Because of the large number of small reservoirs, and less reliable data, individual small reservoir data is not provided. The number of stockponds is a general indicator of small scale surface water capture and livestock demand. Runoff contours reflect the average annual runoff in tributary streams. They provide a generalized indication of the amount of runoff that can be expected at a particular geographic location.

Perennial and Intermittent Streams and Major Springs

A map of perennial and intermittent streams is provided for each basin. For some basins, more than one source of information was used. Stream designations may not accurately reflect current conditions in some cases. Spring data was compiled from a number of sources in an effort to develop as comprehensive a list as possible. Spring data is important to many researchers and to the environmental community due to their importance in maintaining habitat, even from small discharges.

Groundwater Conditions

Several indicators of groundwater conditions are presented for each basin. Aquifer type can be a general indicator of aquifer storage potential, accessibility of the supply, aquifer productivity, water quality and aquifer flux. Well yield information for large diameter wells is provided and is generally measured when the well is drilled and reported on completion reports. It was assumed that large diameter wells were drilled to produce a maximum amount of water and, therefore, their reported pump capacities are indicative of the aquifer's potential to yield water to a well. However, many factors can affect well yields including well design, pump size and condition and the age of the well. Reported well yields are only a general indicator of aquifer productivity and specific information is available from well measurements conducted as part of basin investigations.

Natural recharge is typically the least well known component of a water budget. Many of the estimates in the Atlas are derived from studies of larger geographic areas and all deserve further study. Similarly, estimates of storage are based on rough estimates and considerably more studies are needed in most basins. Components of storage include aquifer depth and specific yield.

Water level data is from measured wells, usually collected during the period when the wells were not actively being pumped or only minimally pumped. Depth to water measurements are shown on mapped wells if there was a measurement taken during 2003-2004. The basin hydrographs show water-level trends for selected wells over the 30-year period from January 1975 to January 2005. Not all basins have a sufficient number of representative hydrographs.

The flow directions that are shown generally reflect long-term, regional aquifer flow in the basin and are not meant to depict temporary or local-scale conditions. However, flow directions in some basins indicate how localized pumping has altered regional flow patterns.

Water Quality

Water quality conditions impact the availability of water supplies. Water quality data was compiled from a variety of sources as described in Volume 1 Section 1.3. The data indicate areas where water quality exceedences have previously occurred, however additional areas of concern may currently exist where water quality samples have not been collected or sample results were not reviewed by the Department (e.g. samples collected in conjunction with the ADEQ Aquifer Protection Permit programs). It is important to note also that the exceedences presented may or may not reflect current aquifer or surface water conditions.

Cultural Water Demand

Cultural water demand is an important component of a water budget. However, without mandatory metering and reporting of water uses, accurate demand data is difficult to acquire. Municipal demand includes water company and domestic (self-supplied) demand estimates. Basin demand information is from several sources in order to prepare as accurate an estimate as possible. Annual demand estimates have been averaged over a specific time period. This provides general trend information without focusing on potentially inaccurate annual demand estimates due to incomplete data.

Locations of major cultural water uses are primarily from a 2004 USGS land cover study using older satellite imagery that may not represent recent changes. The cultural demand maps provide only general information about the location of water users.

Effluent generation data was compiled from several sources to provide an estimate of how much of this renewable resource might be available for use. However, effluent reuse is often difficult both logistically and economically since a potential user may be far from the wastewater treatment plant.

Water Adequacy Determinations

Information on water adequacy and inadequacy determinations for subdivisions, with the reason for the inadequacy determination provides information on the number and status of subdivision lots. Listing the reason for the inadequacy identifies which subdivisions have a demonstrated physical or legal lack of water or may have elected not to provide the necessary information to the Department. Briefly, developers of subdivisions outside of AMAs are required to obtain a determination of whether there is sufficient water of adequate quality available for 100 years. If the supply is determined to be inadequate, lots may still be sold, but the condition of the water supply must be disclosed in promotional materials and in sales documents.

In addition to these subdivision determinations for which a water adequacy report is issued, water providers may apply for adequacy designations for their entire service area. There are six Designations of Adequate Water Supply in the planning area. (See Section 5.0.5). If a subdivision is to be served water from one of these water providers, then a separate adequacy determination is not required. (See Appendix A, Volume 1 for more information about the Adequacy Program).

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